

# Analysis of AIRS 06/14/2002 Focus Data

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- Cloud flag
- Noise characterization using Earth scene data
- Obs-Calcs using PREPQC
- Broadband radiance evaluation using GEOS
- Surface Emissivity Survey



AIRS Science Team Net-Meeting, 03 July 2002



# Cloud flag

- **Approach:**

Tb thresholds plus spatial coherence test

- **Thresholds:**

Clear if :

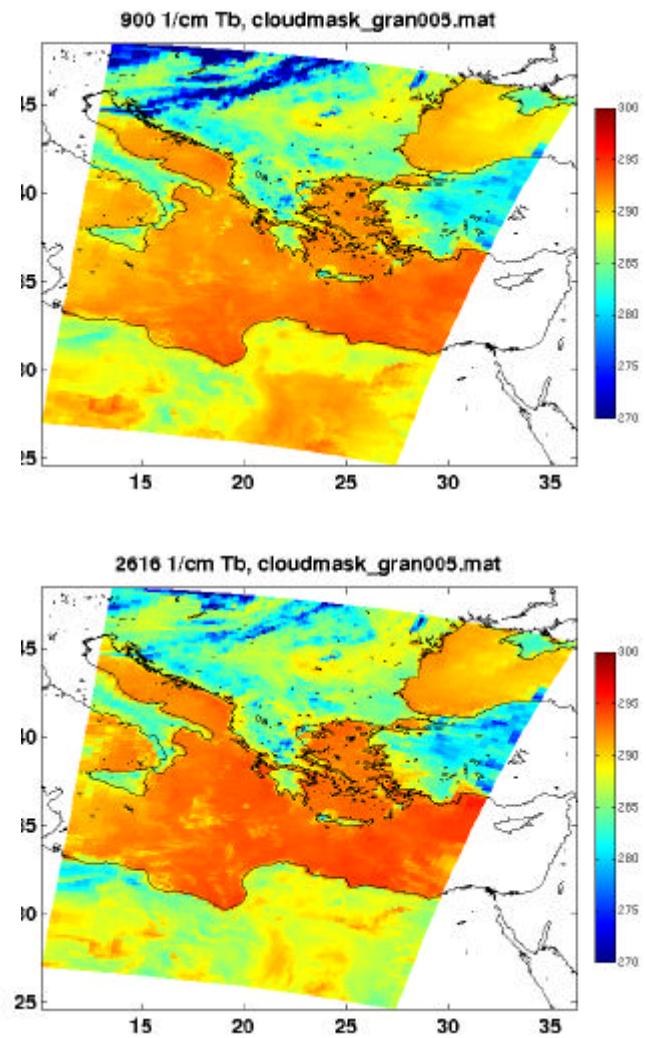
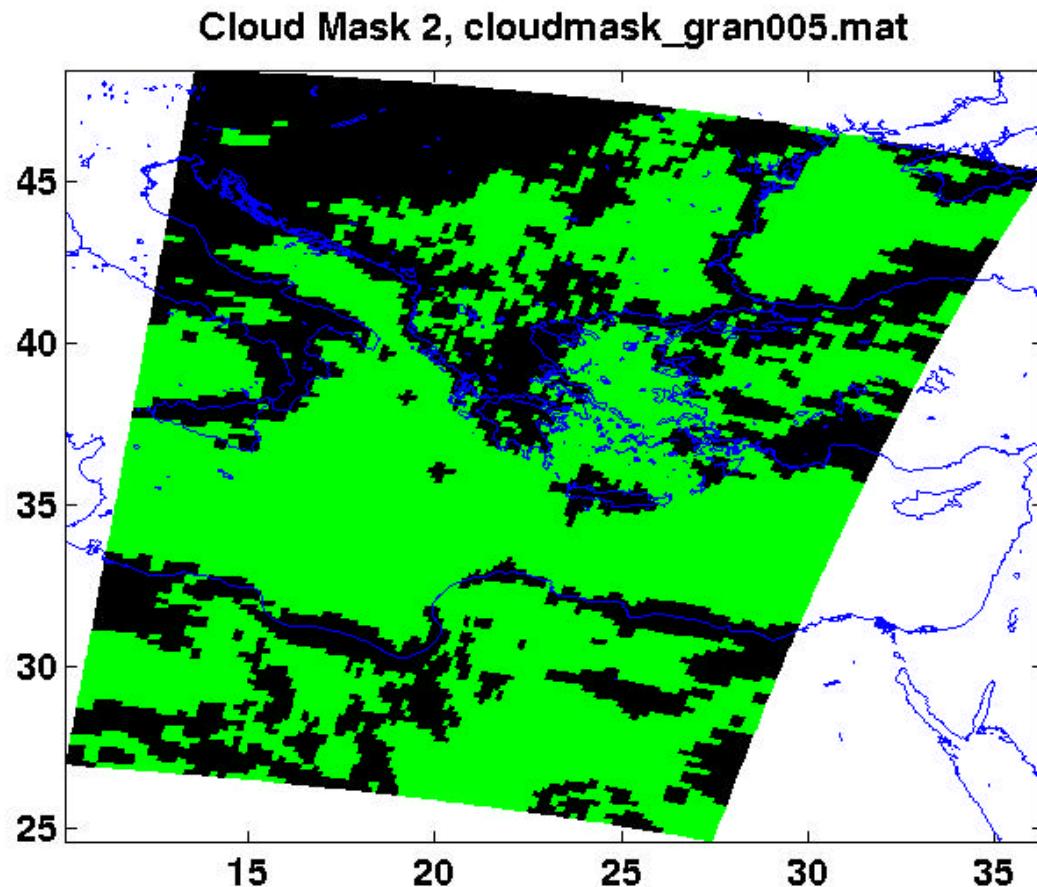
- $Tb(1127 \text{ cm}^{-1}) > 295\text{K}$
- $Tb(11.5\mu\text{m}) > 270\text{K} \text{ & } Tb(10.5\mu\text{m}) - Tb(12.5\mu\text{m}) < 3\text{K}$
- $Tb(\text{offline}) - Tb(\text{online}) < -0.5 \text{ K}$

$$Tb(\text{on-line}) = \langle 814-815 \text{ cm}^{-1} \rangle Tb, Tb(\text{off-line}) = \langle 818-822 \text{ cm}^{-1} \rangle Tb$$

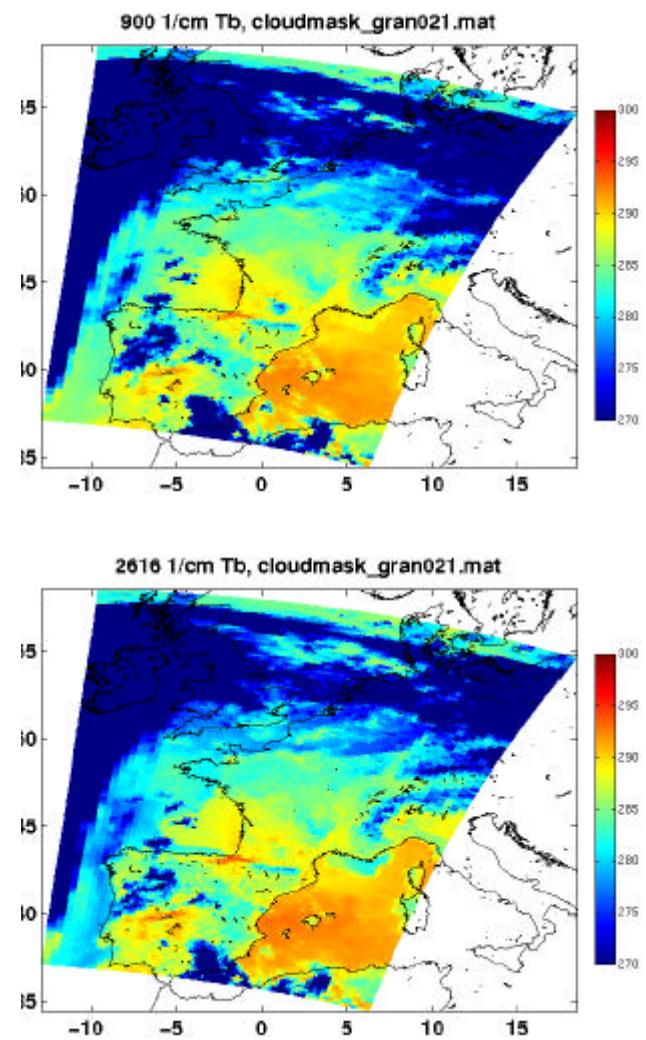
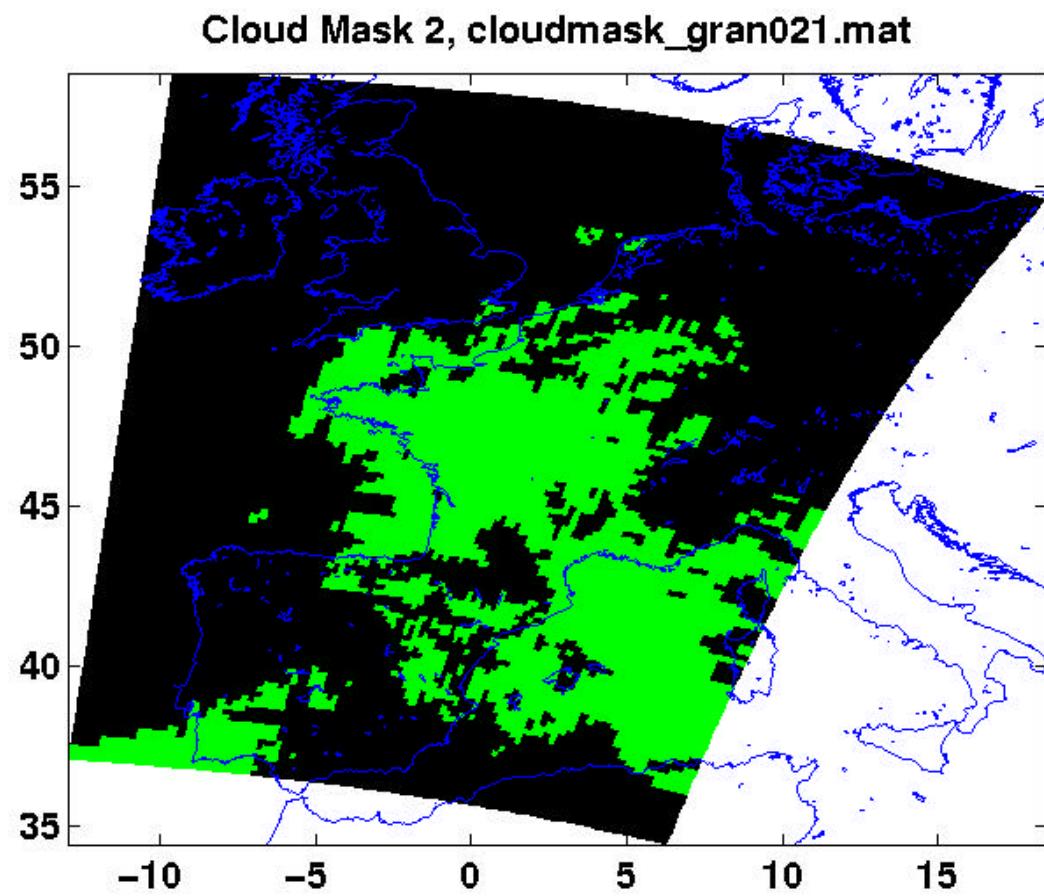
- **Spatial Coherence:**

- $Tb(90,135) = 2616 \text{ cm}^{-1}$  brightness temperature image
- Clear if  $|Tb(I,J) - Tb(I,J+n)| < 2n, |Tb(I,J) - Tb(I+n,J)| < 2n$

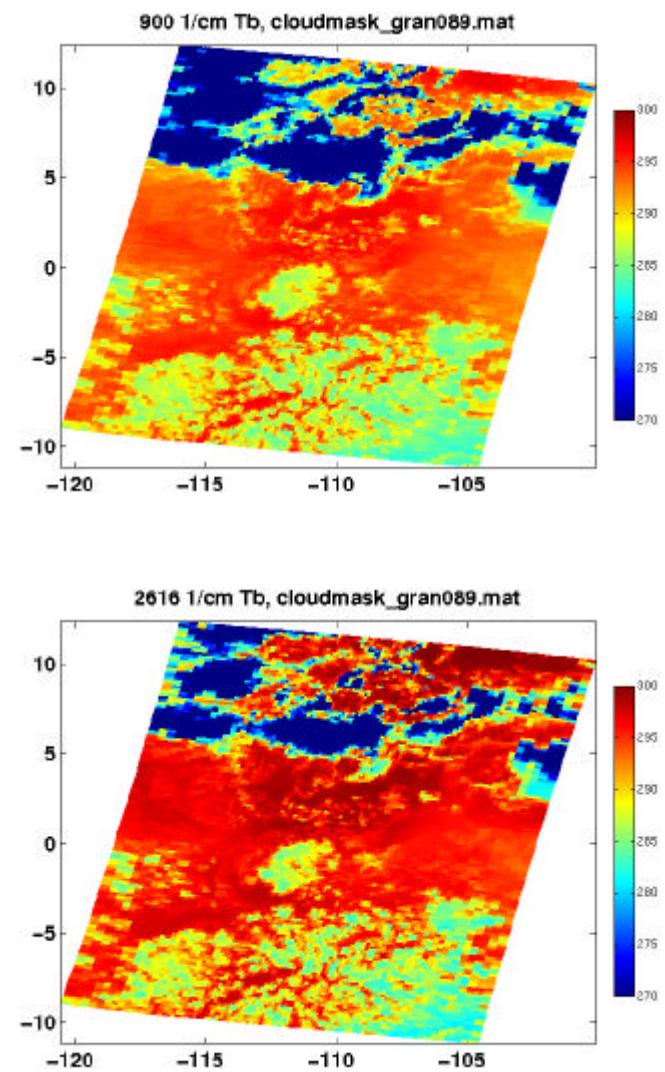
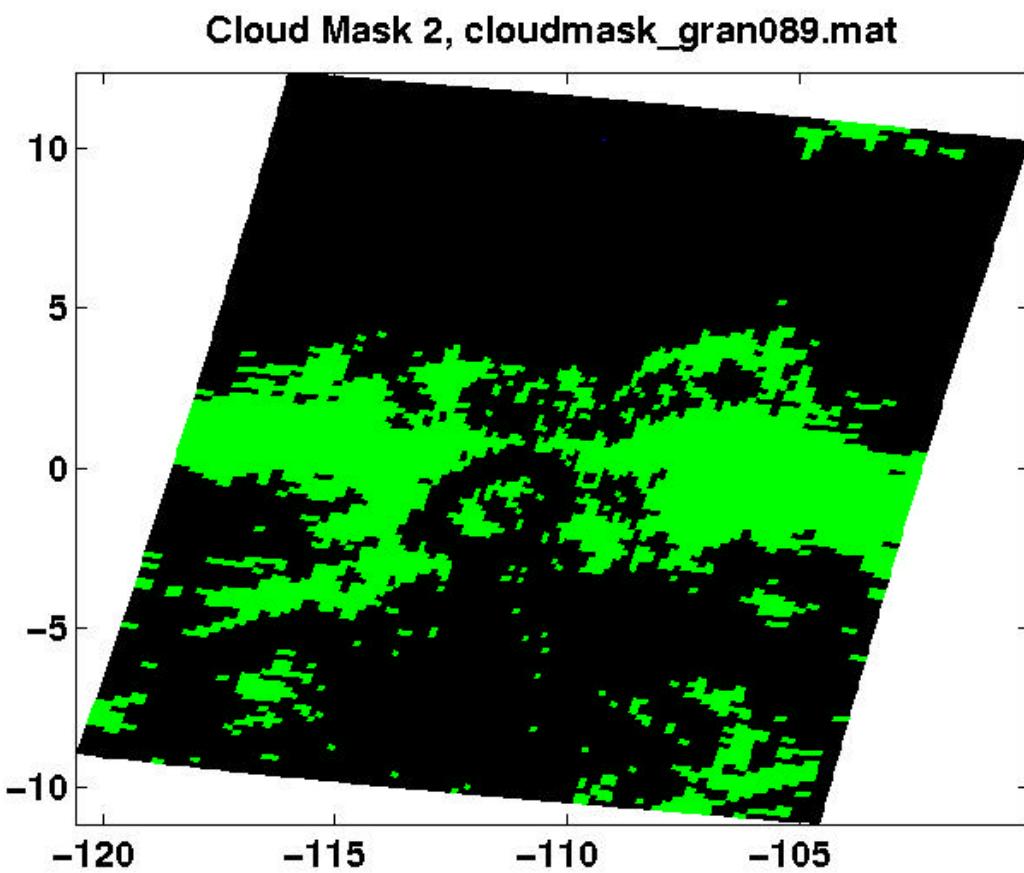
# granule 005



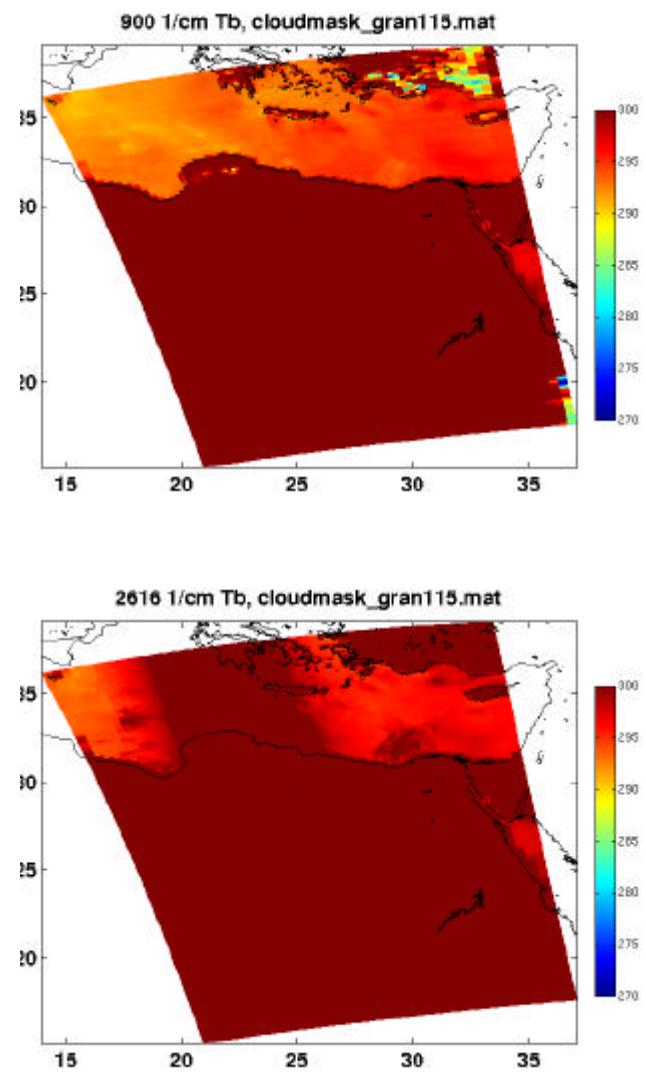
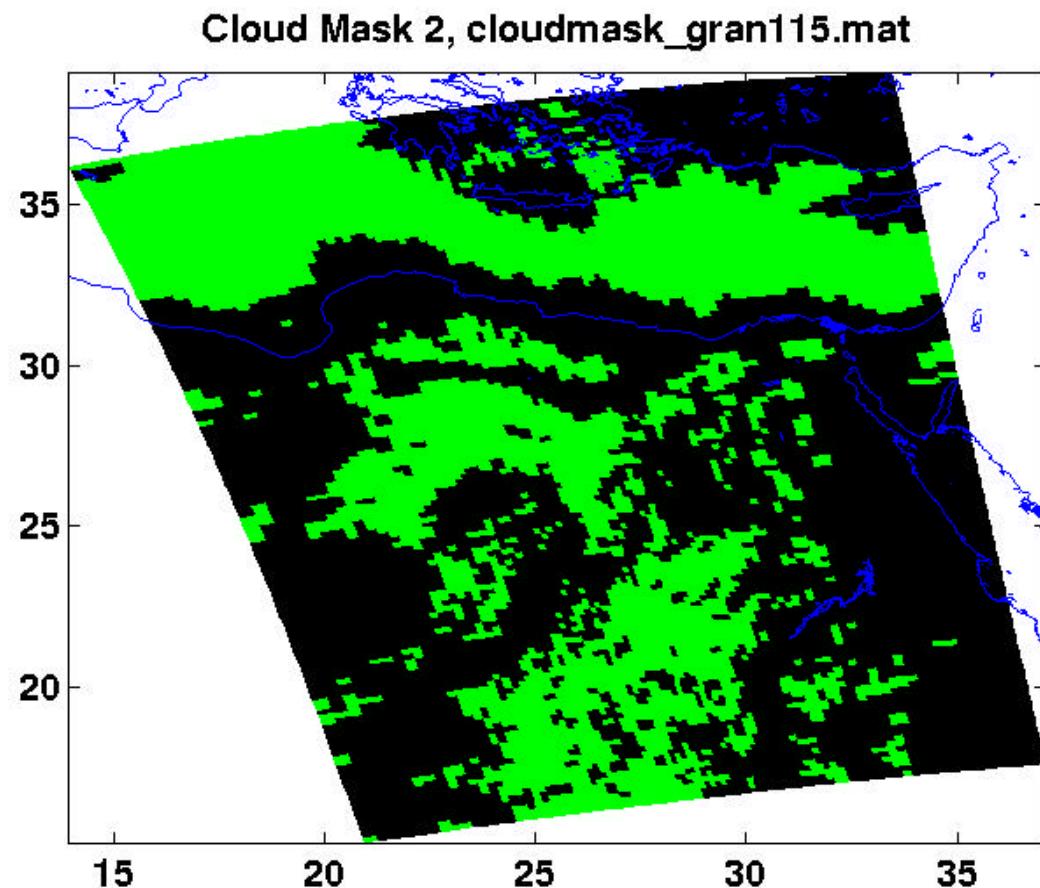
# granule 021



# granule 089

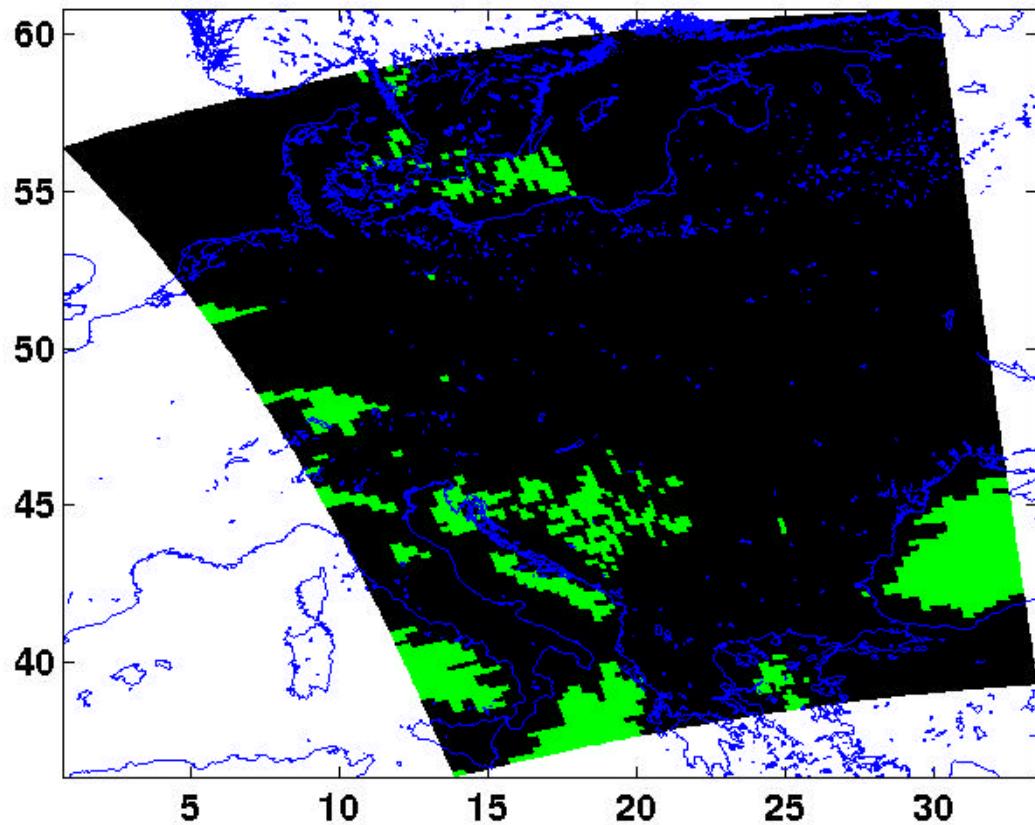


# granule 115

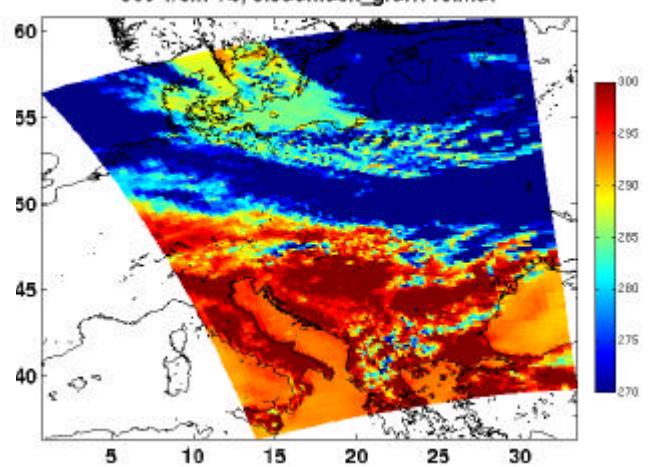


# granule 116

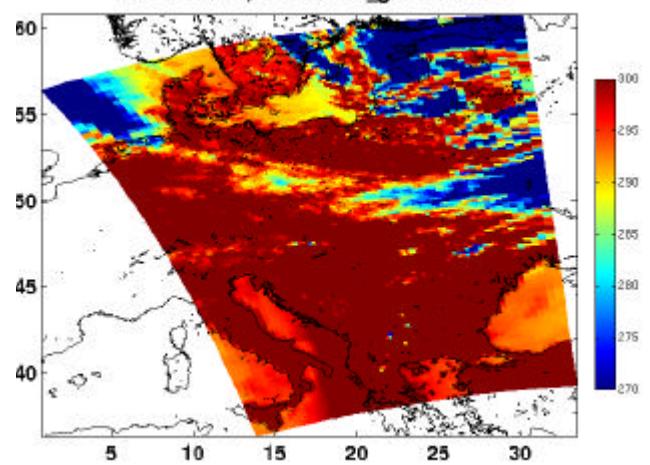
Cloud Mask 2, cloudmask\_gran116.mat



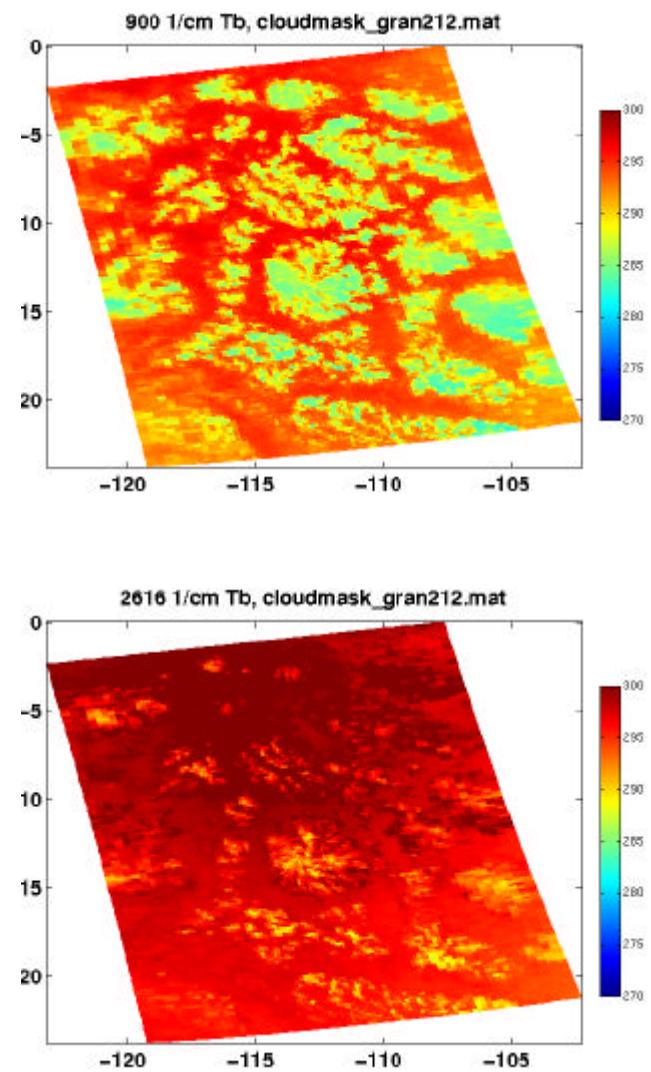
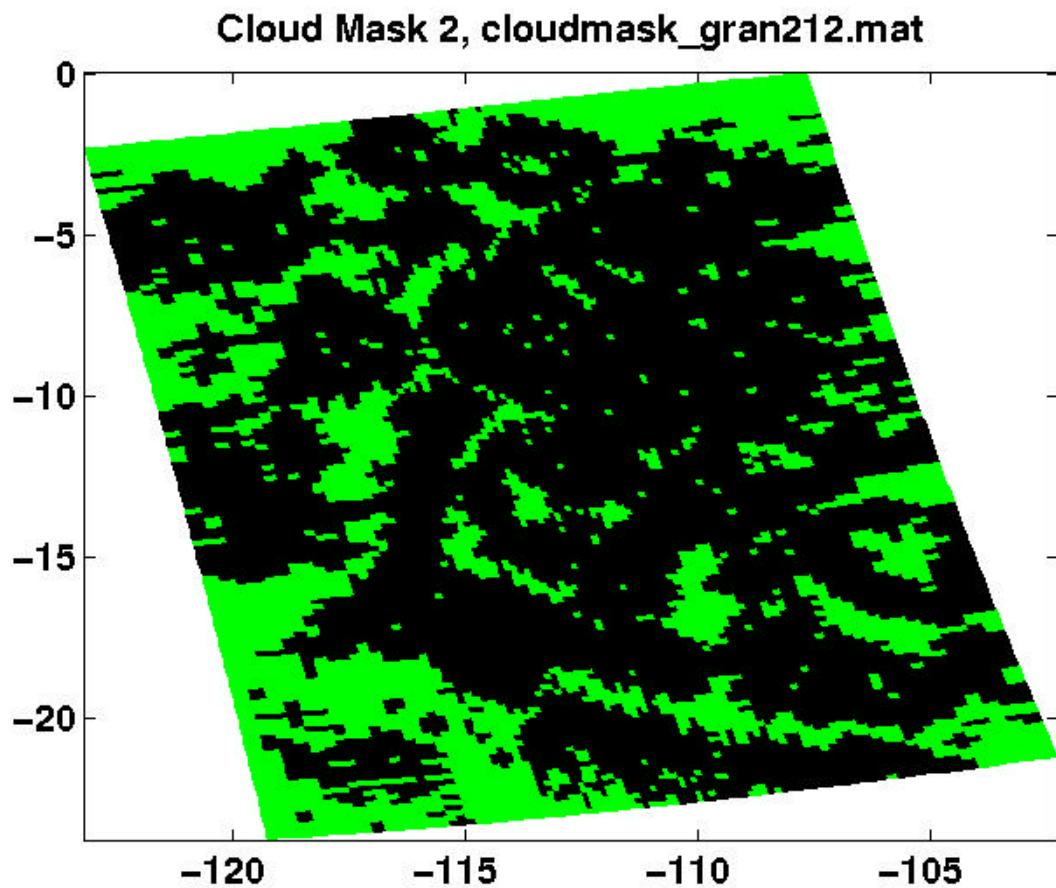
900 1/cm Tb, cloudmask\_gran116.mat



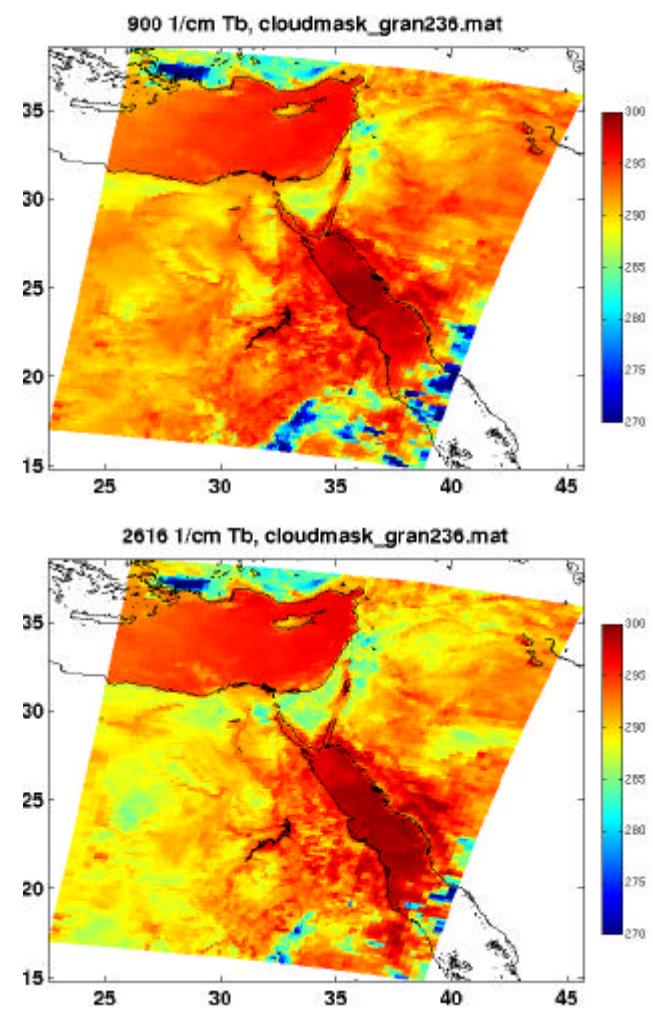
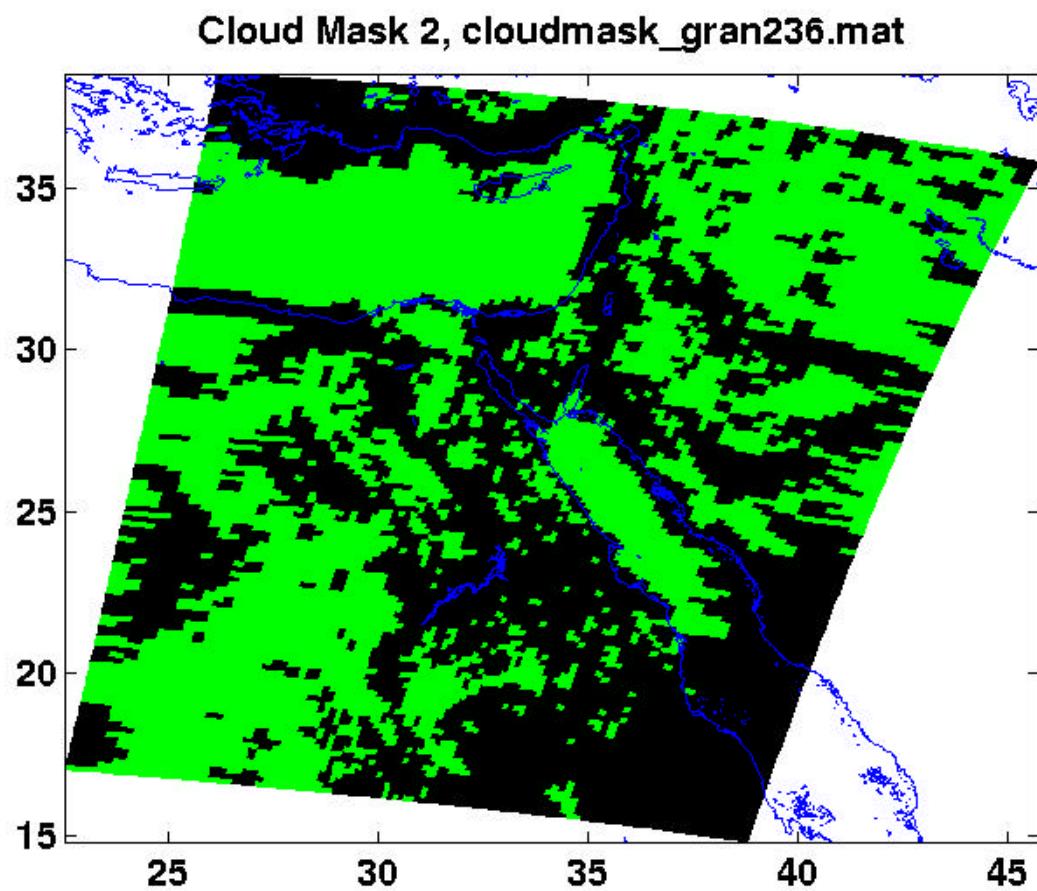
2616 1/cm Tb, cloudmask\_gran116.mat



# granule 212



# granule 236

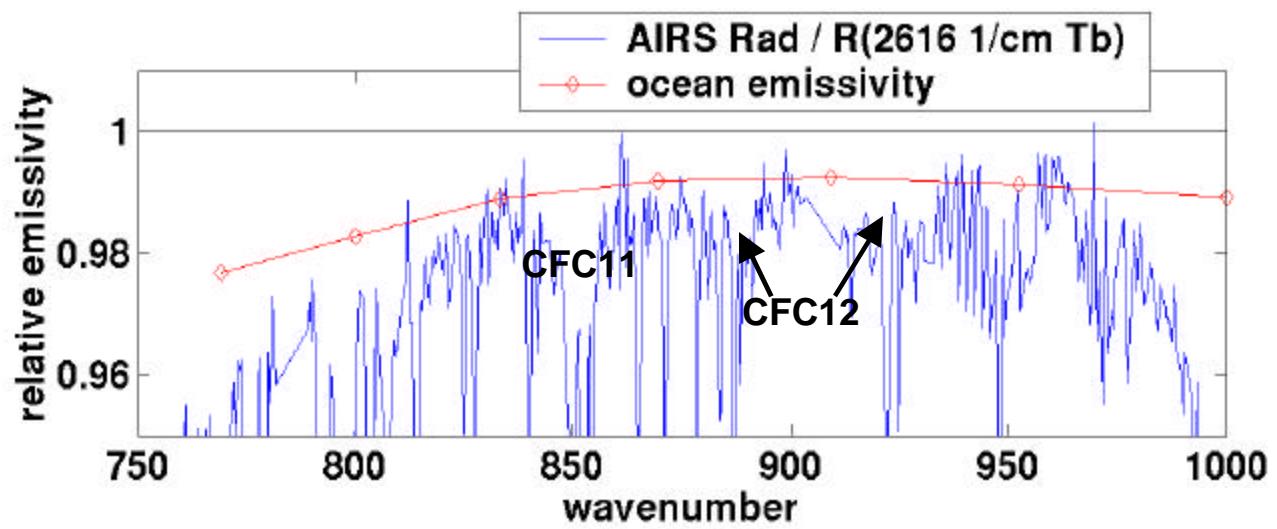
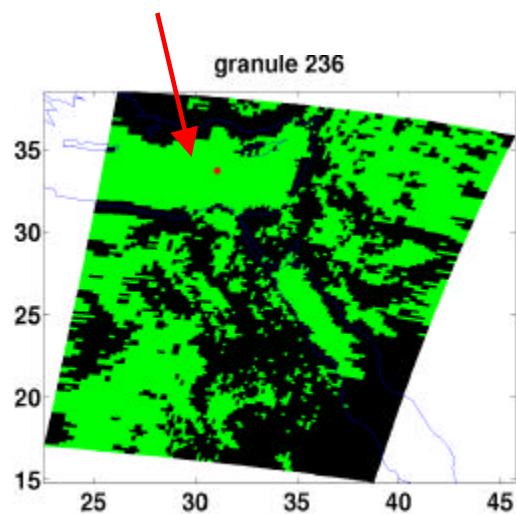


# Cloud flag

- **Summary:**

- AIRS-only threshold + spatial coherence cloud flag
- working reasonably well over water
- surface variations are mistaken for clouds
- needs refinement and validation

- **Validation (?)**



# NeDT estimation using Earth scene data

- **Approach:**

Using all spectra from a granule:

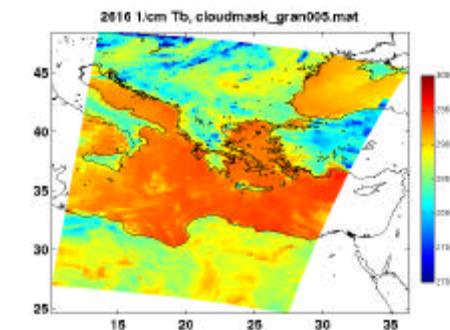
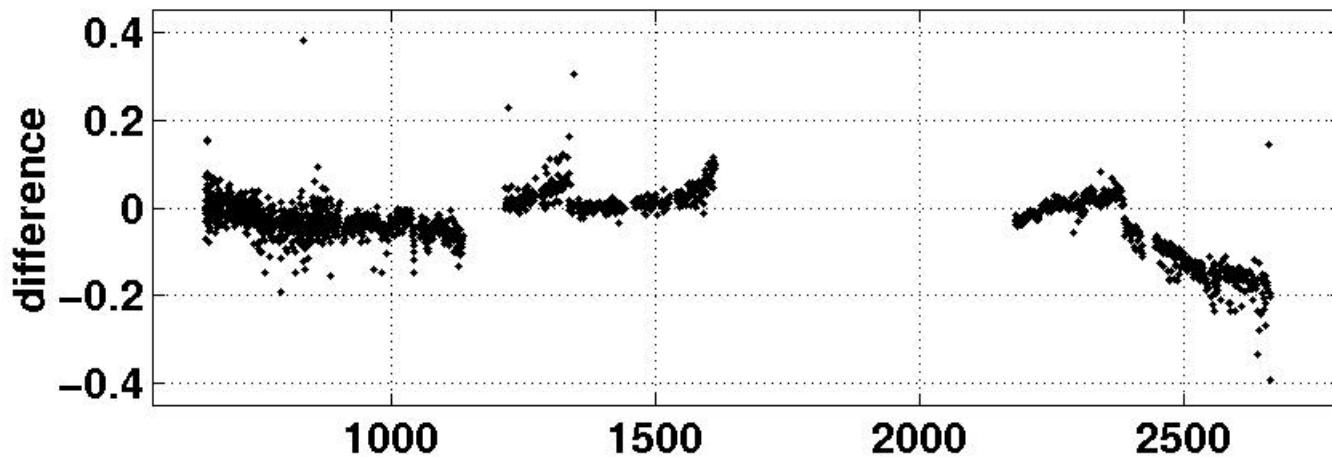
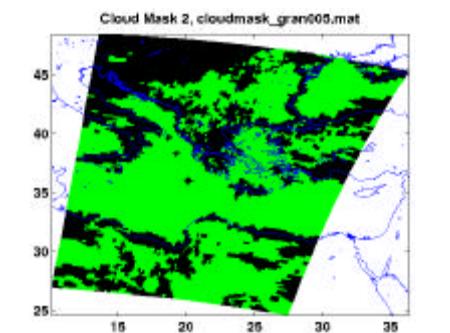
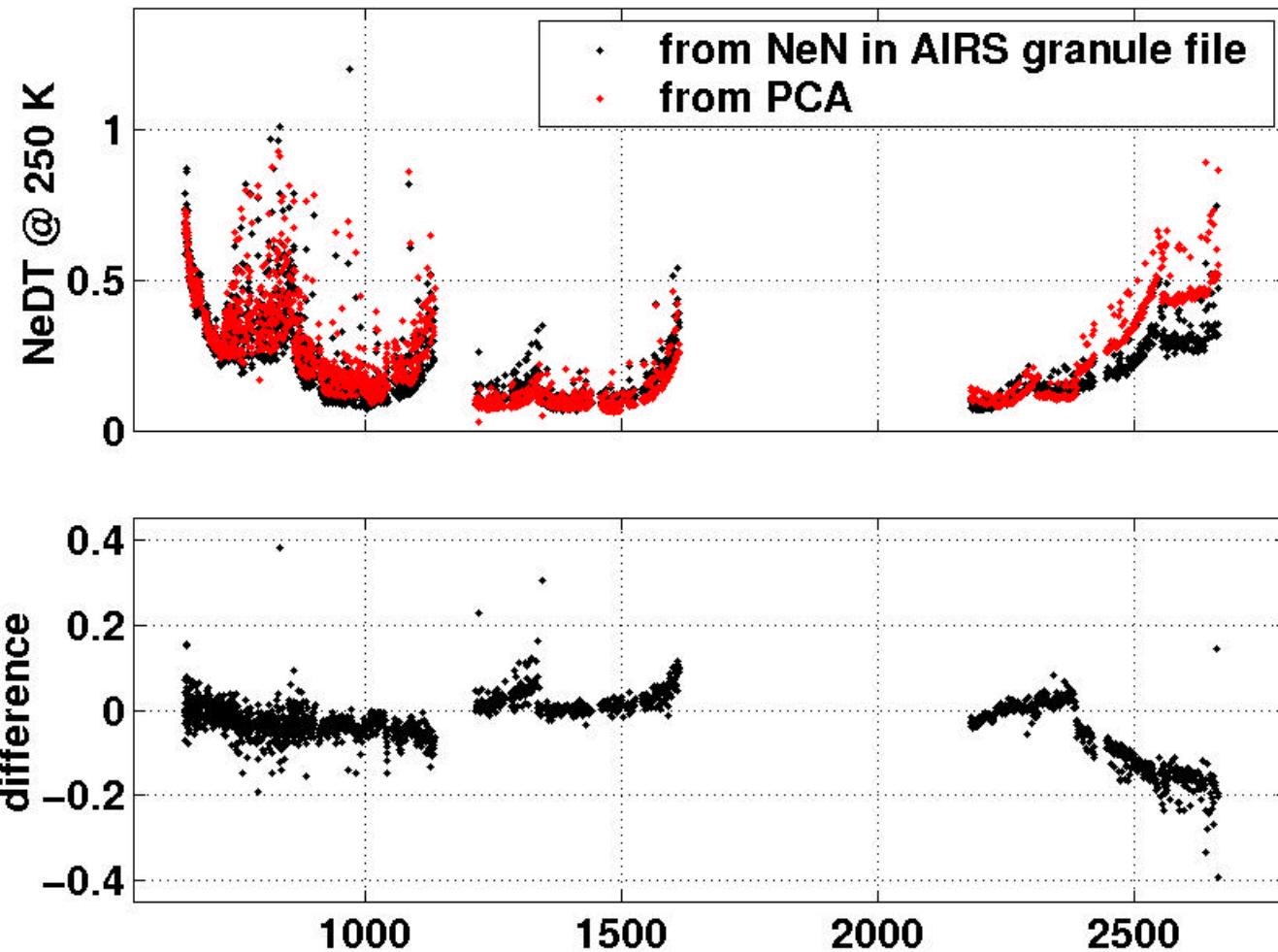
- 1) generate principle components (PCs) of the covariance matrix of the spectra within the granule
- 2) reconstruct the spectra using a reduced number of PCs, and
- 3) use statistics of the reconstruction error to derive noise estimates.

- **Focus Data Analysis:**

- \* Channel filter :  $CalChanSummary \leq 2 \text{ & } ExcludedChans == 0 \text{ & } \text{all}(CalFlag == 2)$
- Granules 005, 021, 089, 115, 116, 212, 236
- Shortwave analysis using granule 116

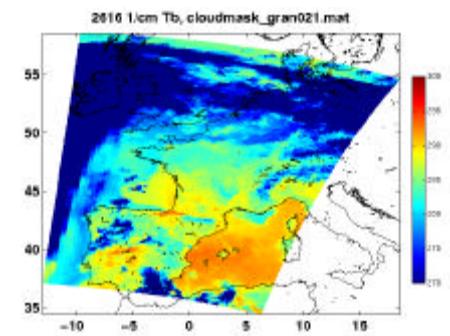
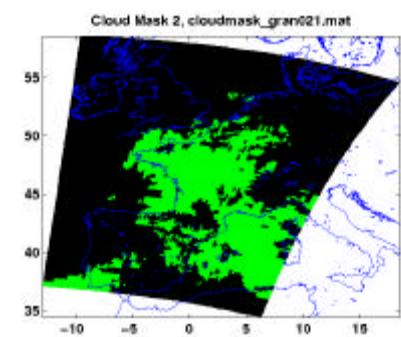
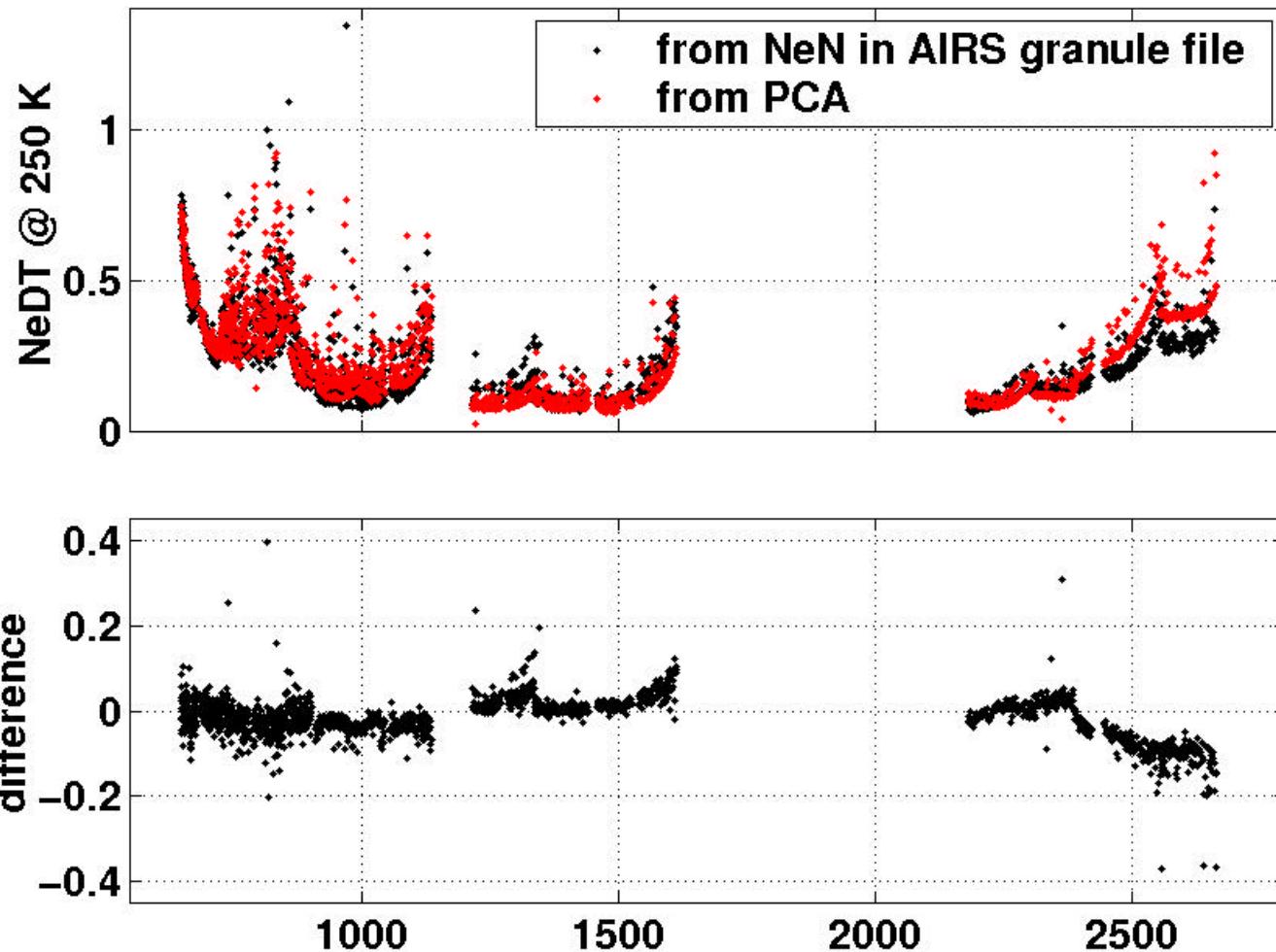
# granule 005

nedt.2002.06.14.005.mat



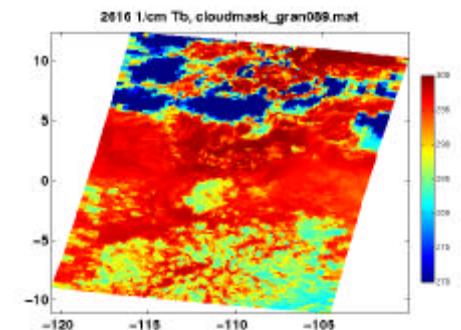
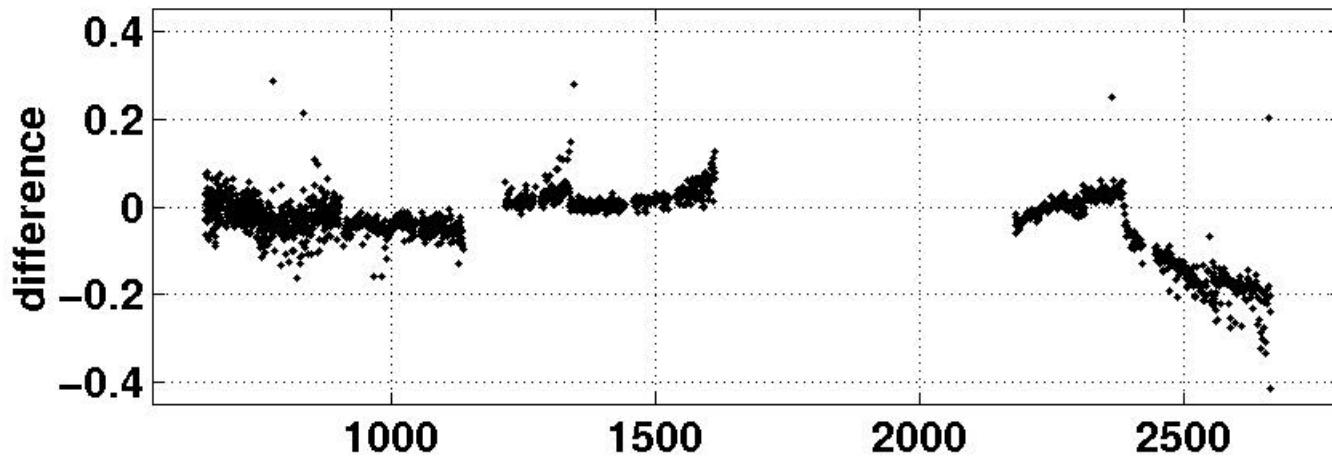
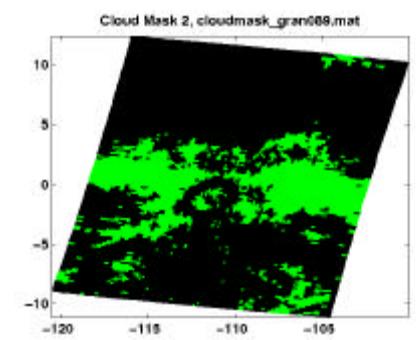
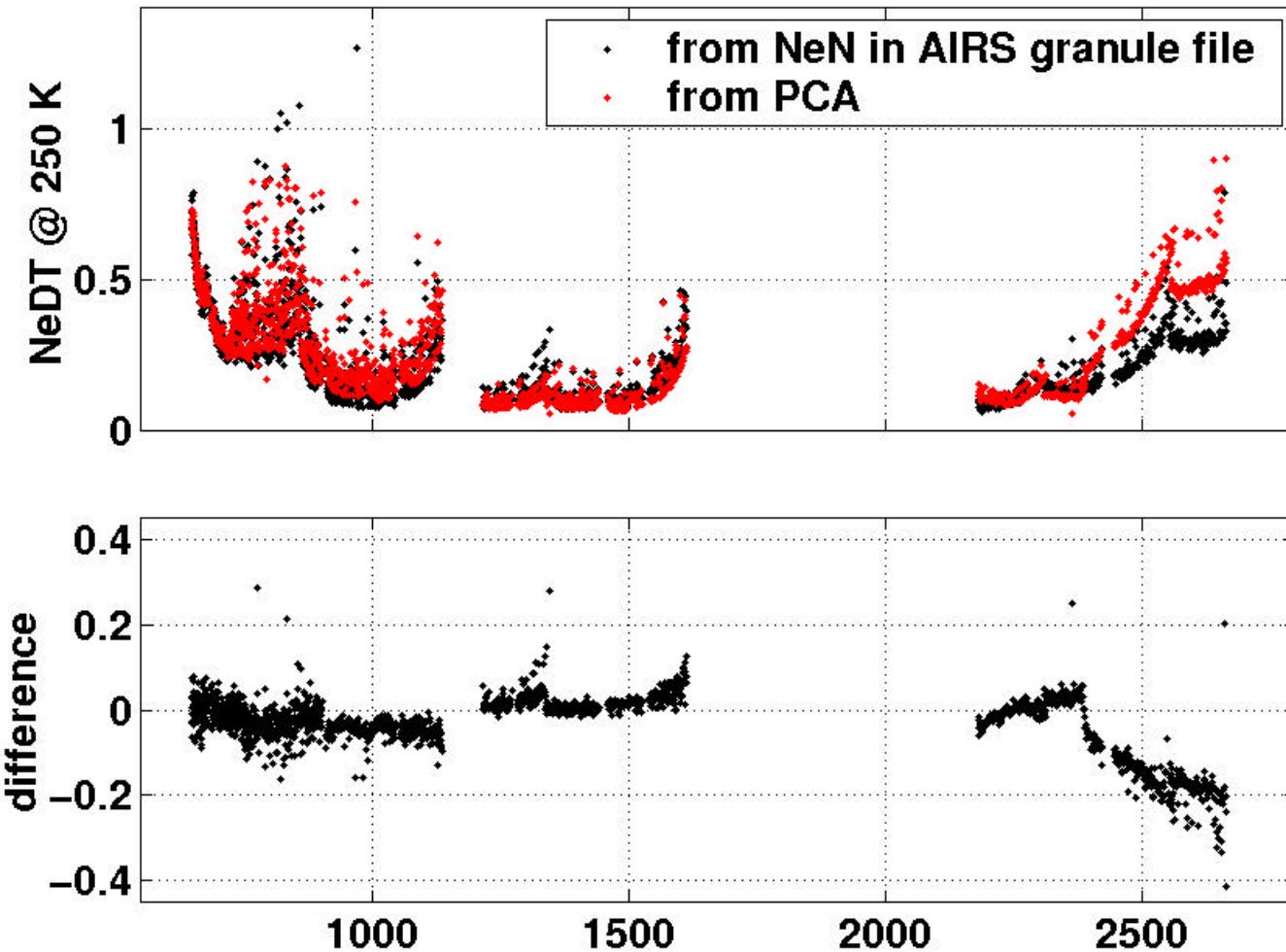
# granule 021

nedt.2002.06.14.021.mat



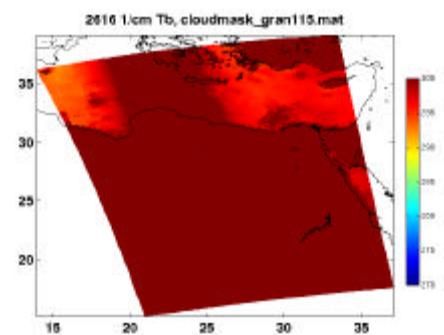
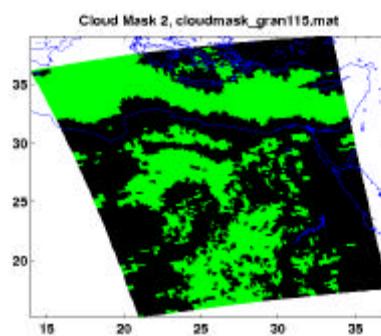
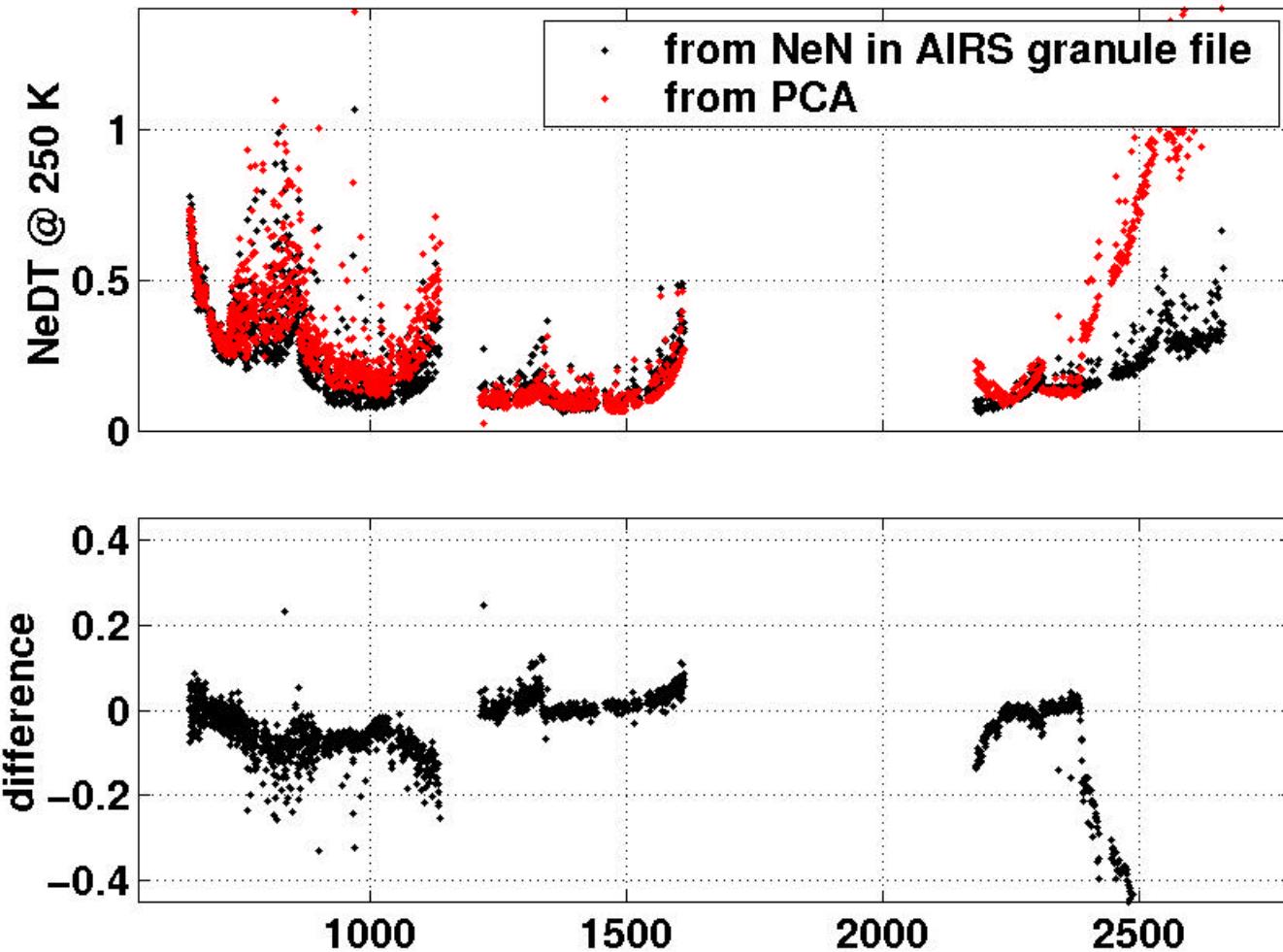
# granule 089

nedt.2002.06.14.089.mat



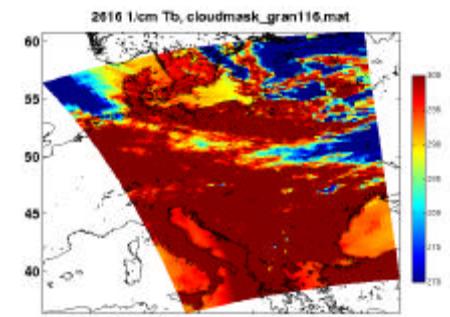
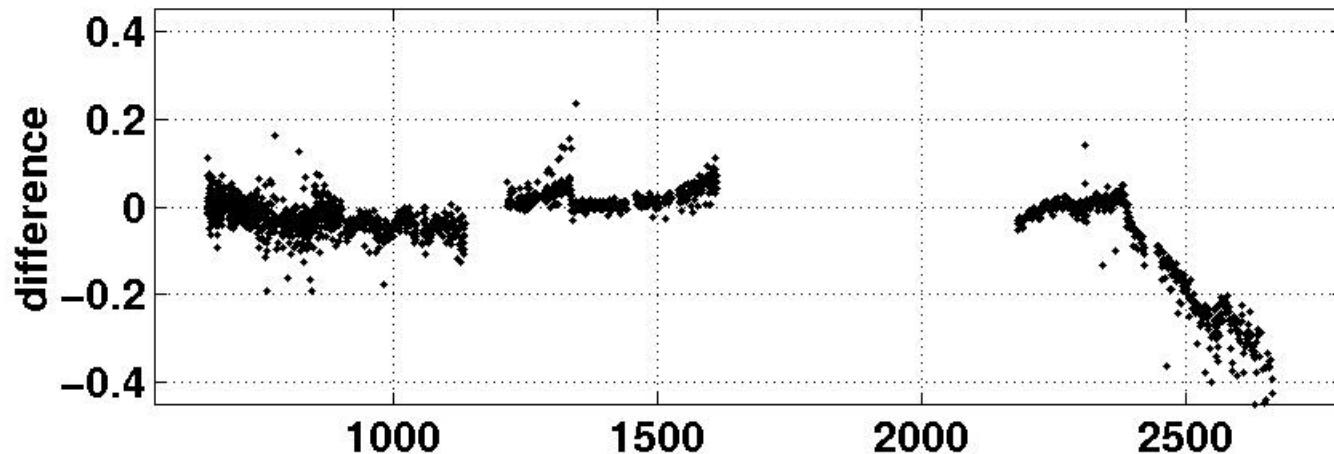
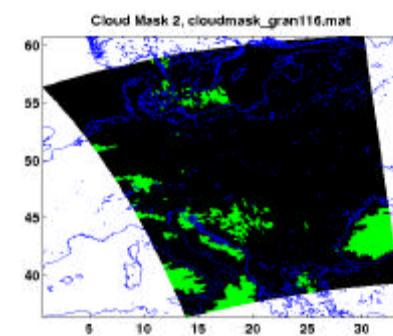
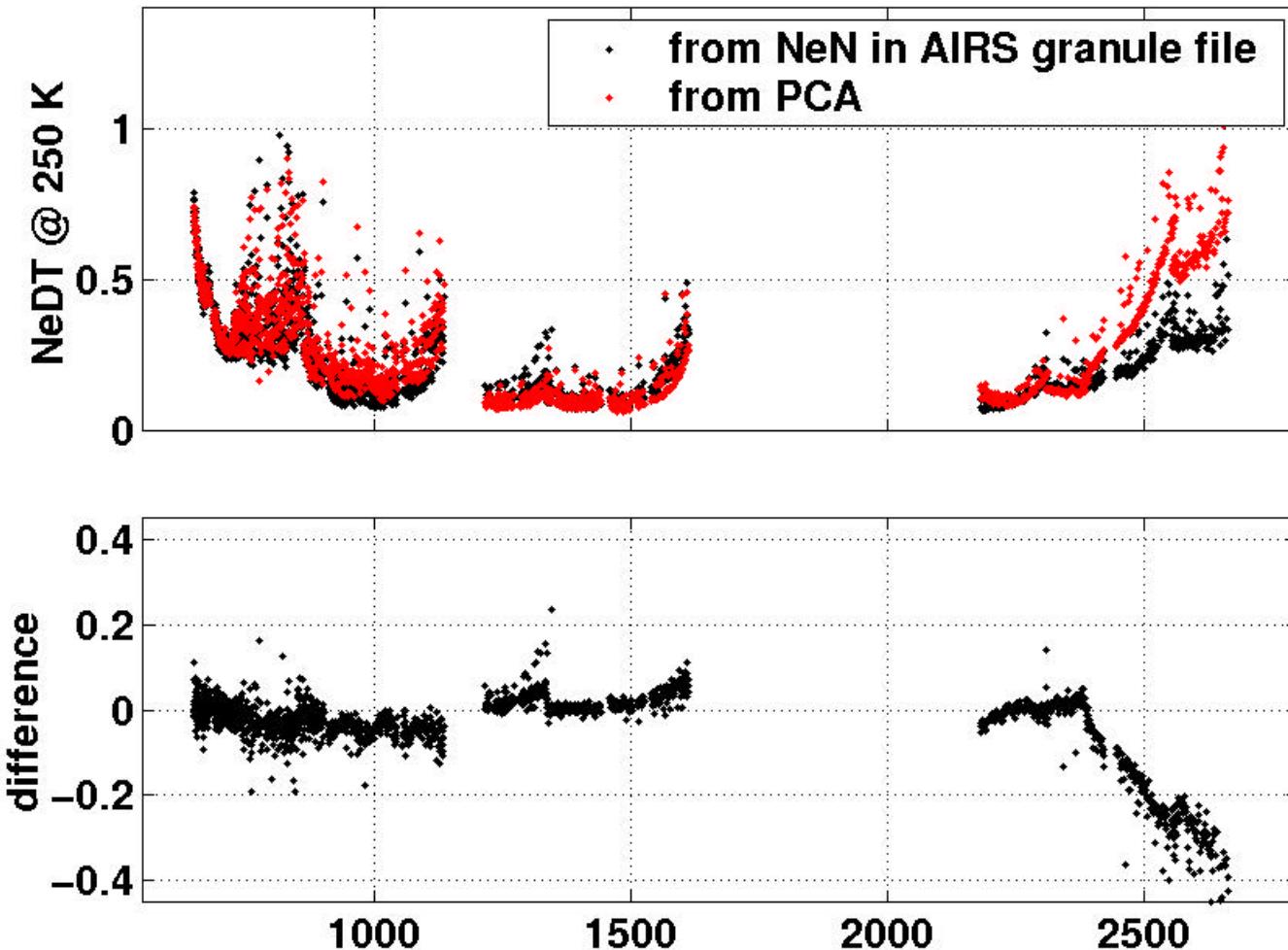
# granule 115

nedt.2002.06.14.115.mat



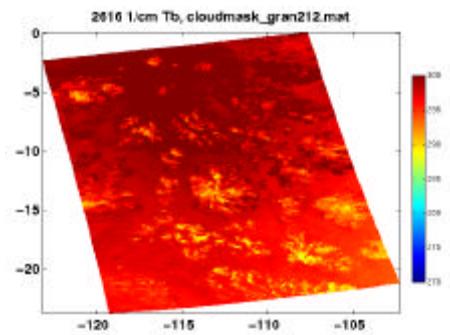
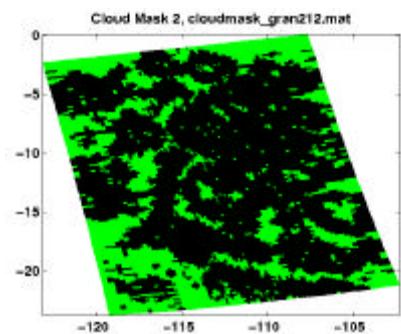
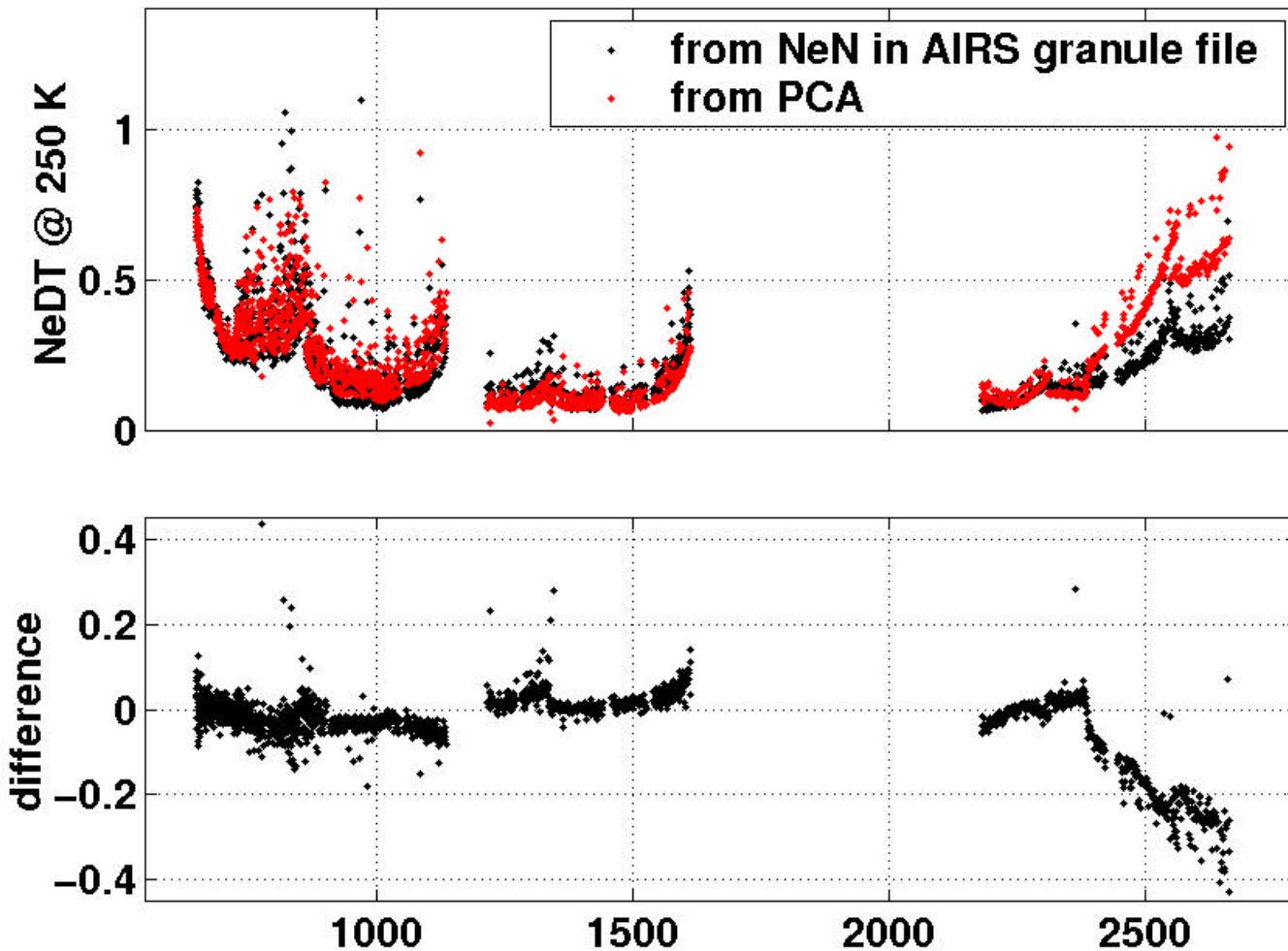
# granule 116

nedt.2002.06.14.116.mat



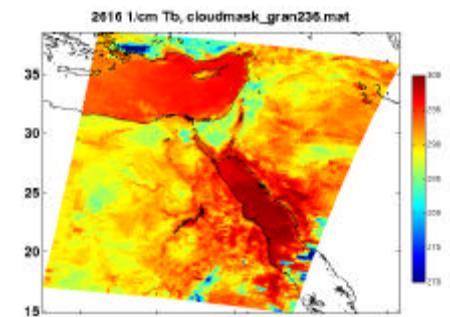
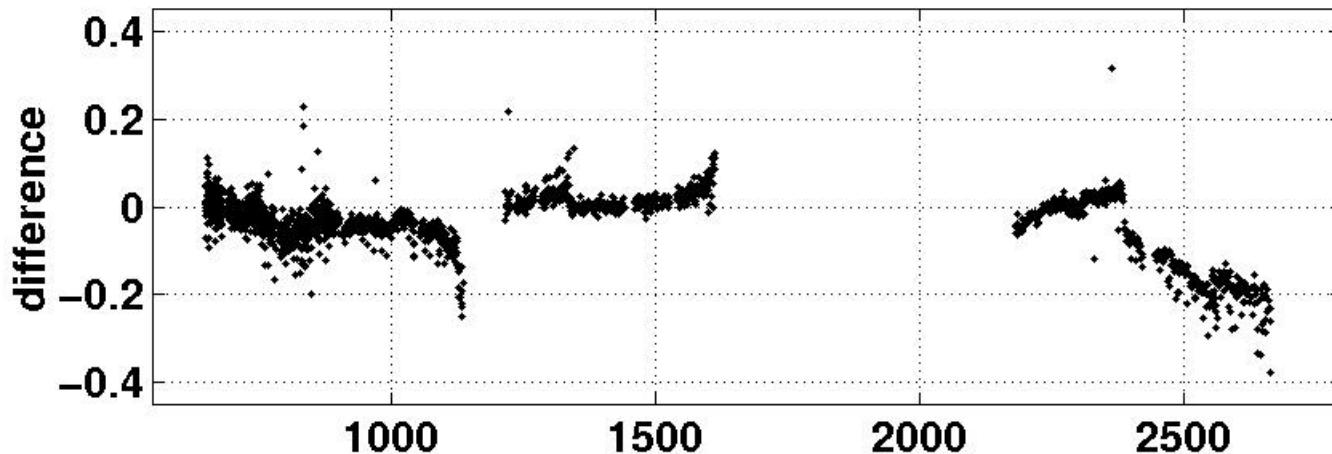
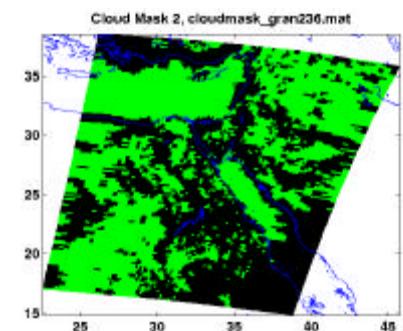
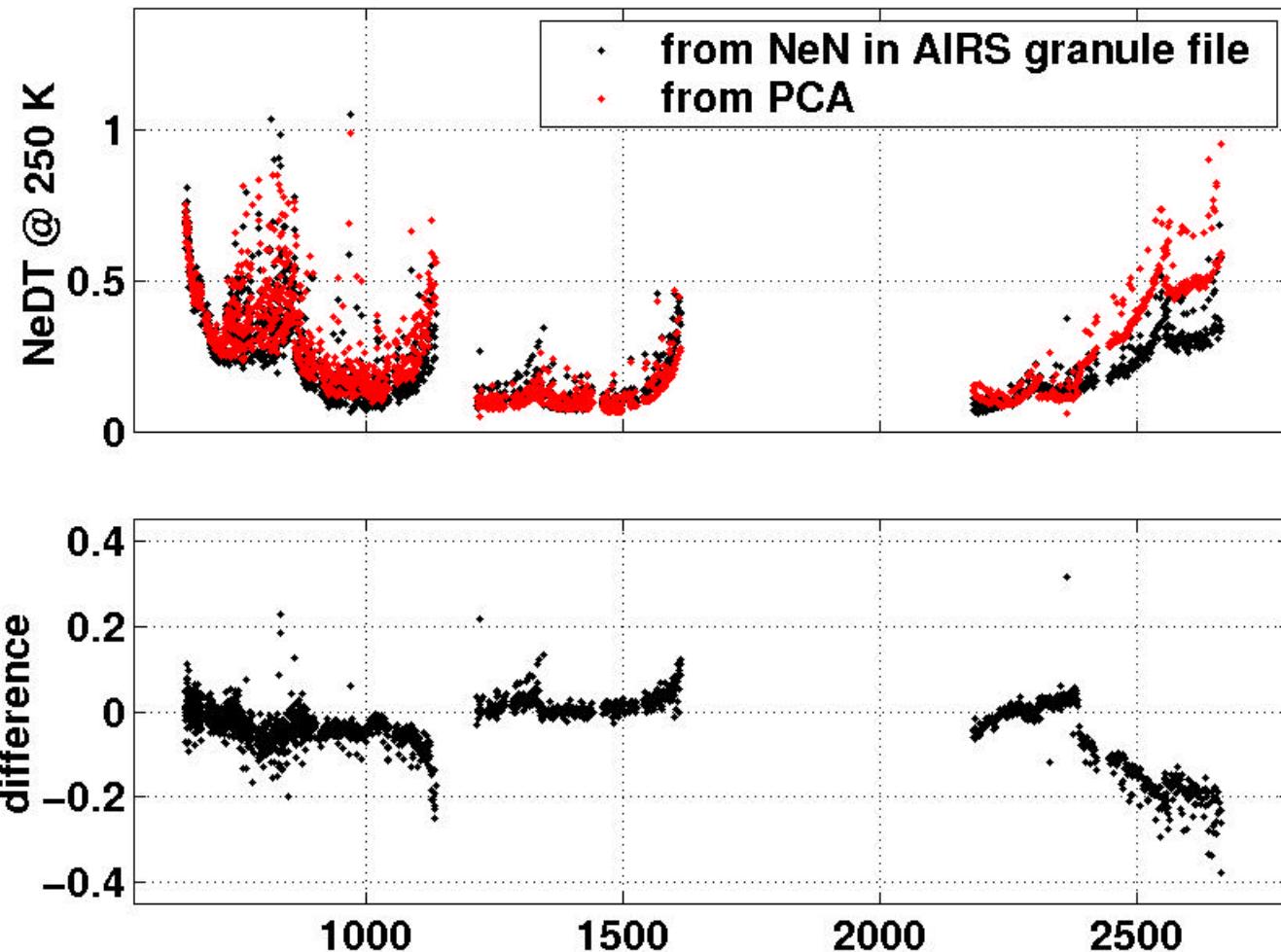
# granule 212

nedt.2002.06.14.212.mat

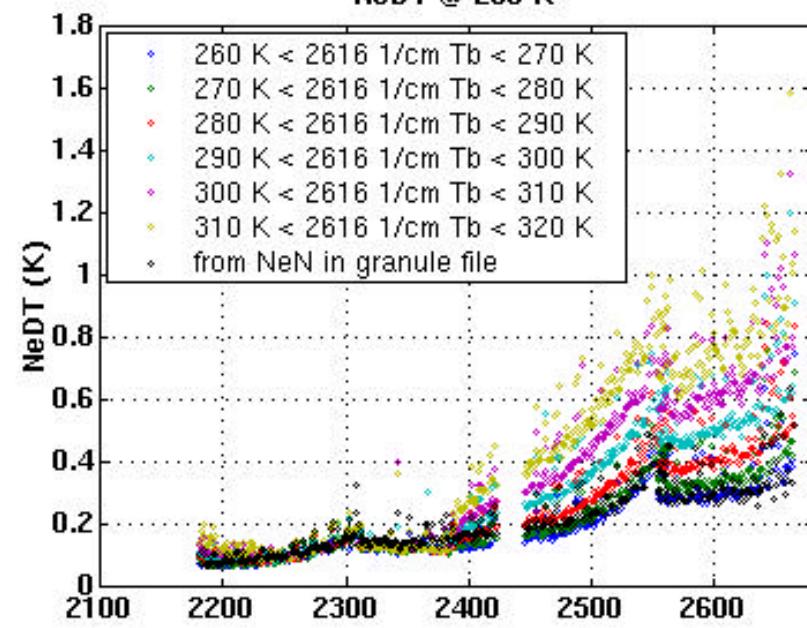
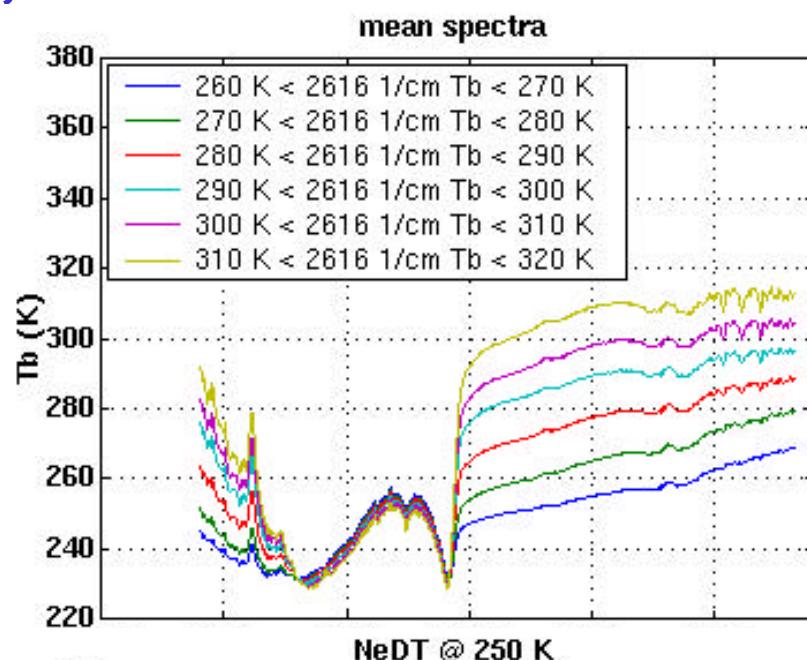
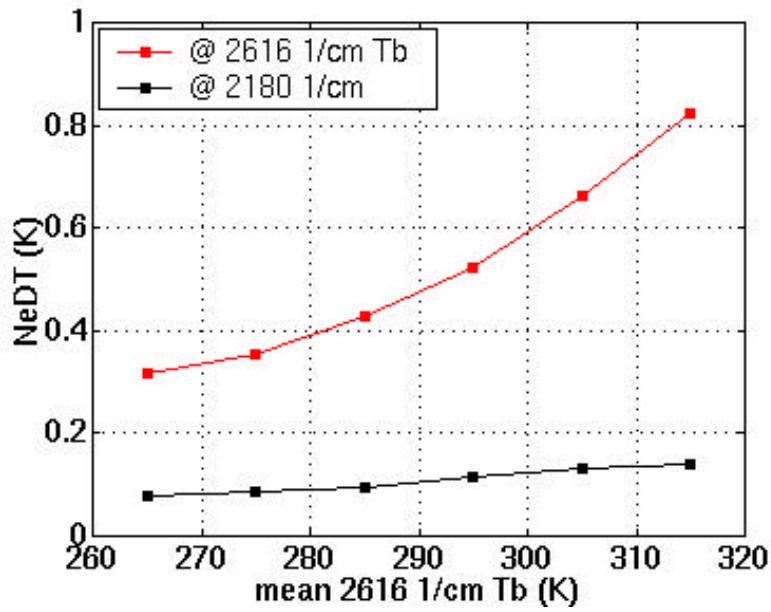
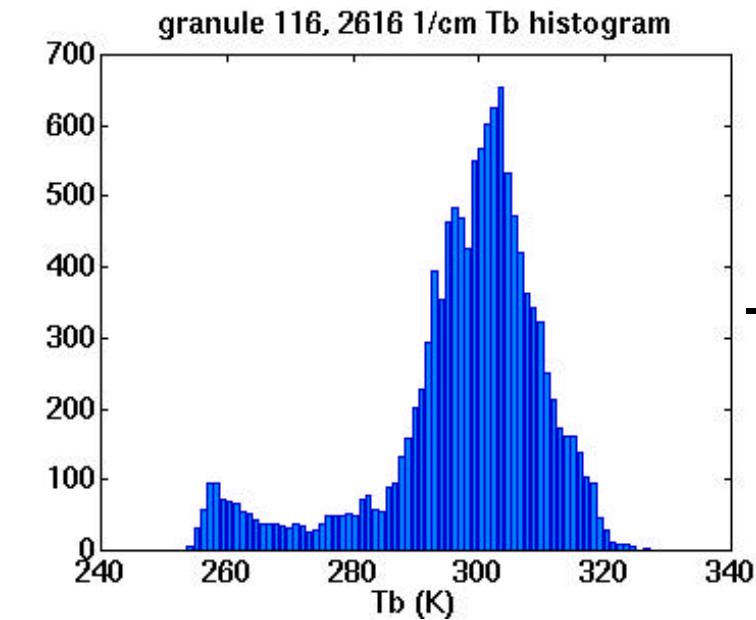


# granule 236

nedt.2002.06.14.236.mat



# granule 116, shortwave



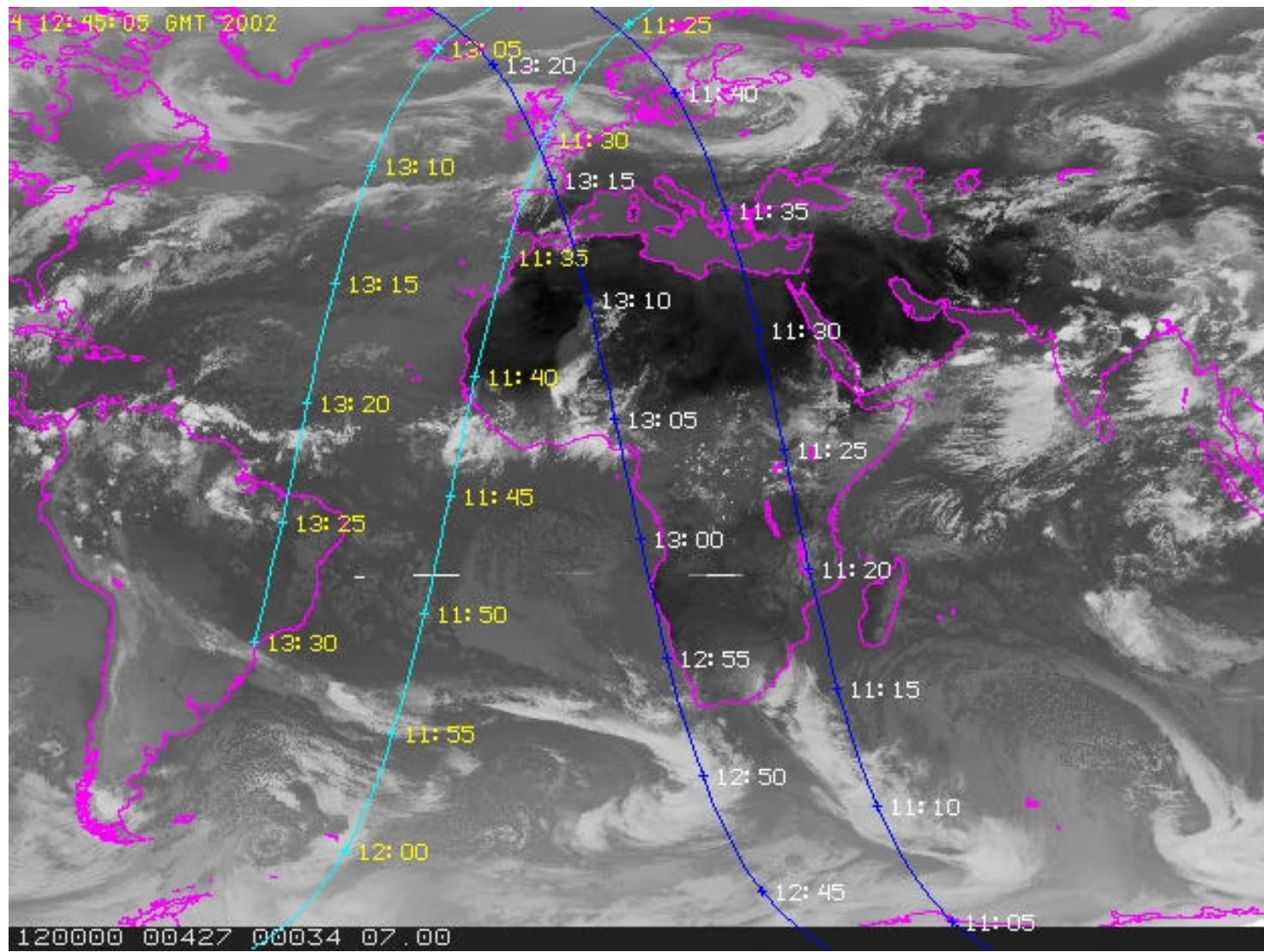
# NeDT estimation using Earth scene data

- **Summary:**

- Longwave and Midwave:
  - PCA derived noise estimates (NeDT @ 250K) agree to better than ~0.1 K (with a small number of outliers) with NeN's provided in the granule files, and with values in the pre-launch channel properties file.
    - Longwave PCA values are slightly higher than NeN's in granule files
    - Midwave PCA values are slightly lower than NeN's in granule files
- Shortwave
  - Shortwave photon-limited noise demonstrated with granule 116.
    - PCA analysis for 260-270K earth scenes yields noise estimates similar to NeN's provided in the granule file.
    - (What are NeN's provided in the granule file ?)

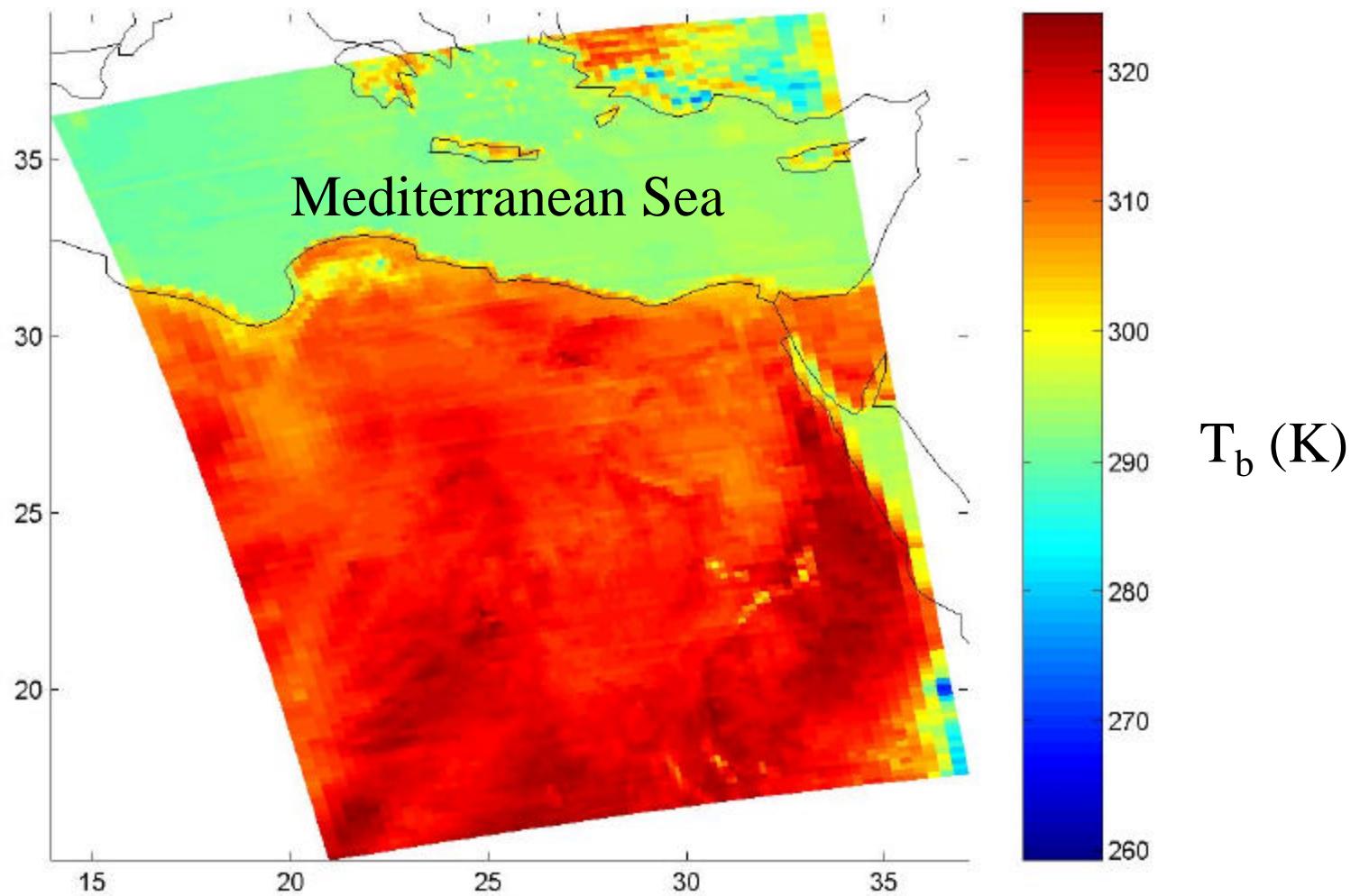
# Striping or 1/f -noise Investigation

Granule 115, 1131 UTC, Day, 14 June 2002



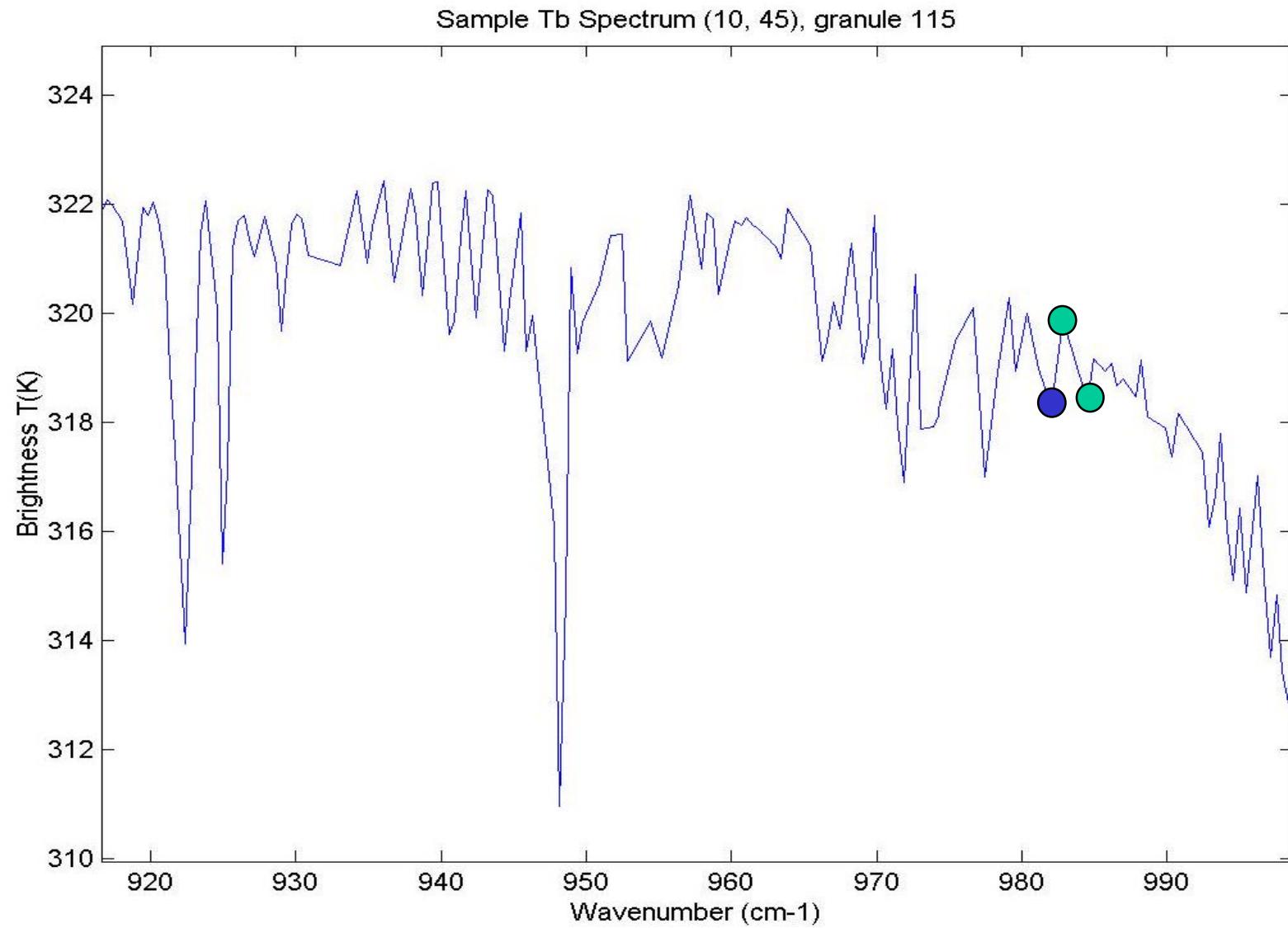
# **982.01cm<sup>-1</sup> Brightness Temperature**

## **Granule 115, 14 June 2002**



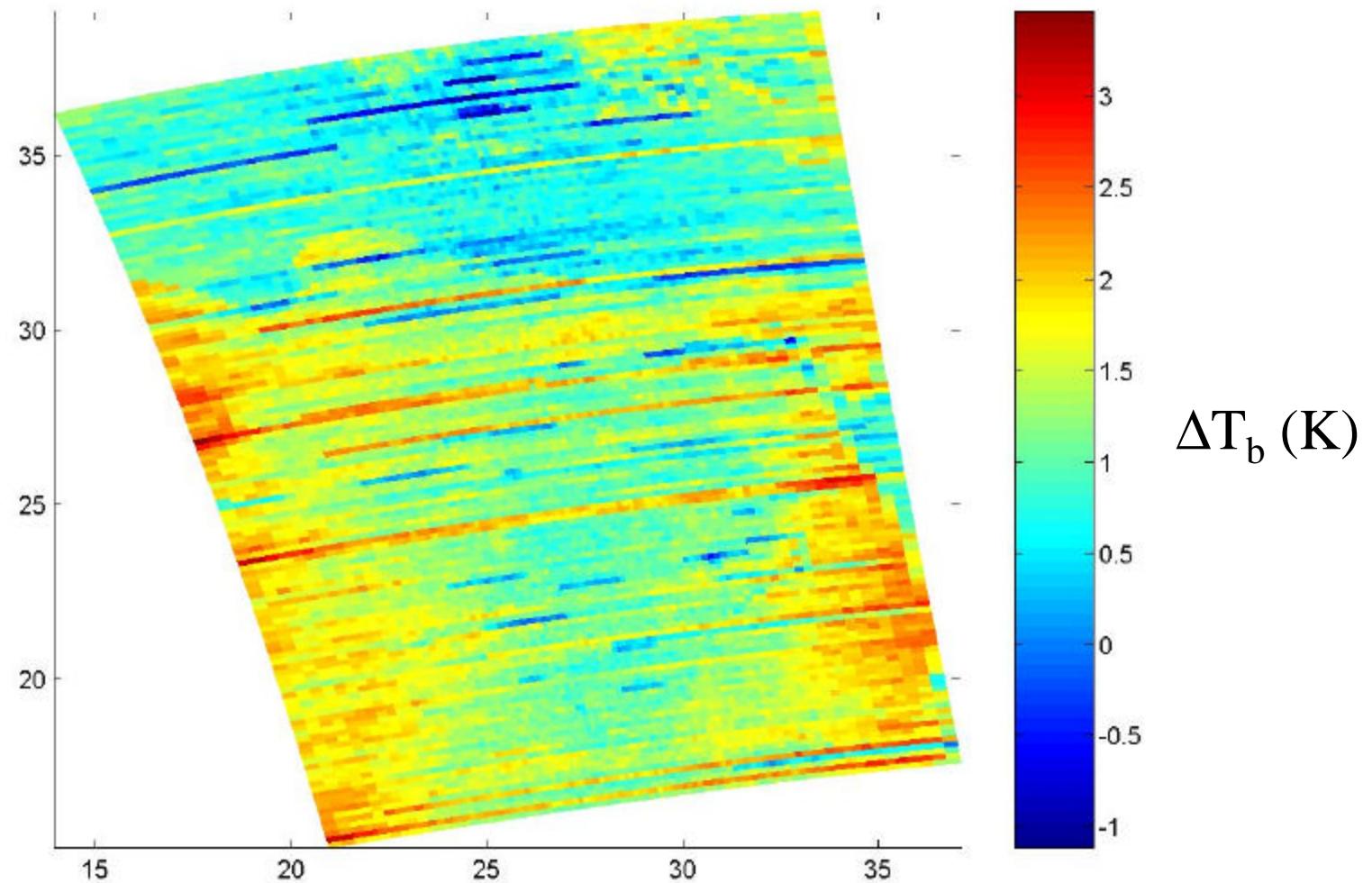
# Selected LW Window Channels

## Granule 115, 14 June 2002



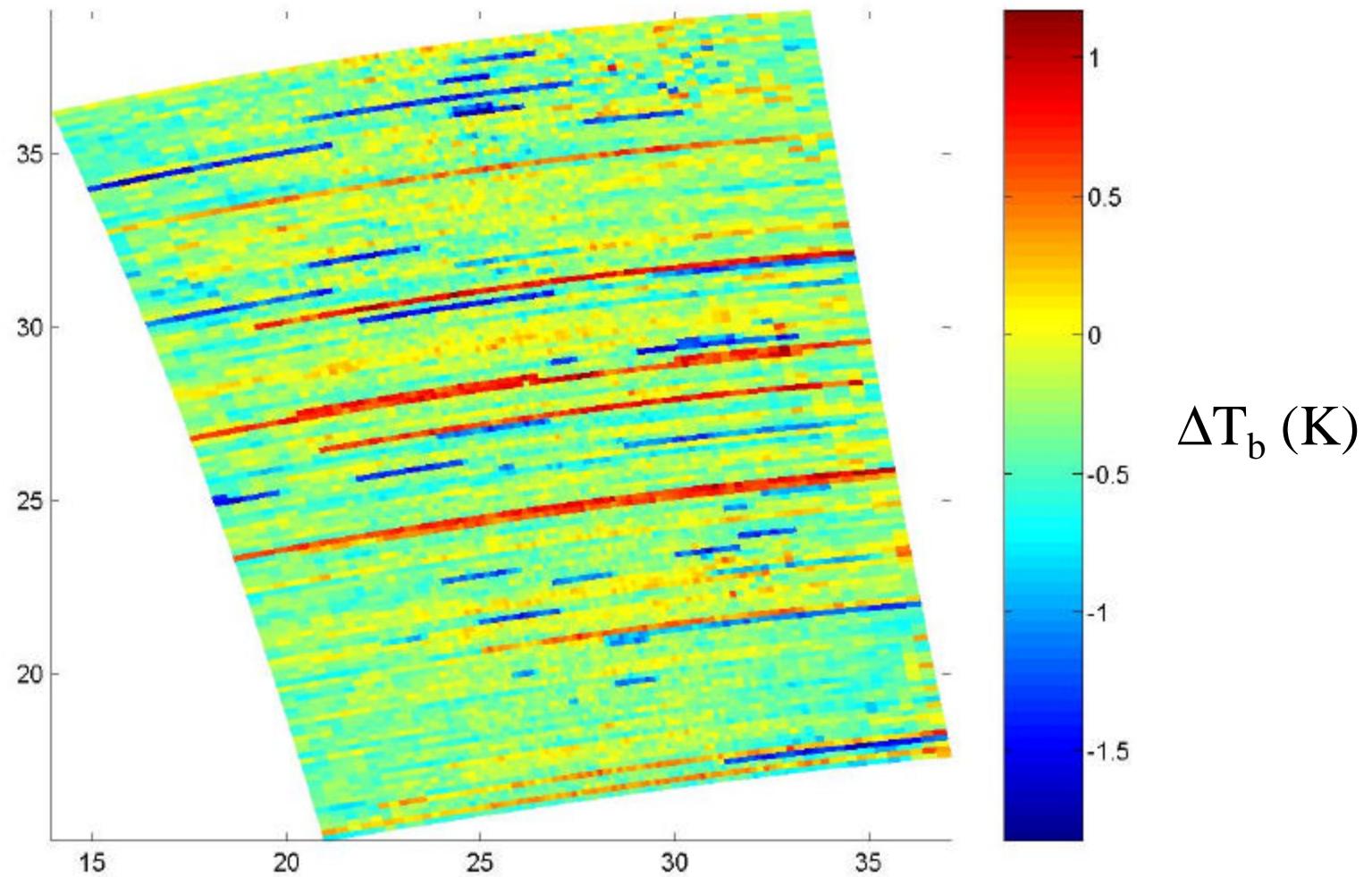
# 982.84 - 982.01 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



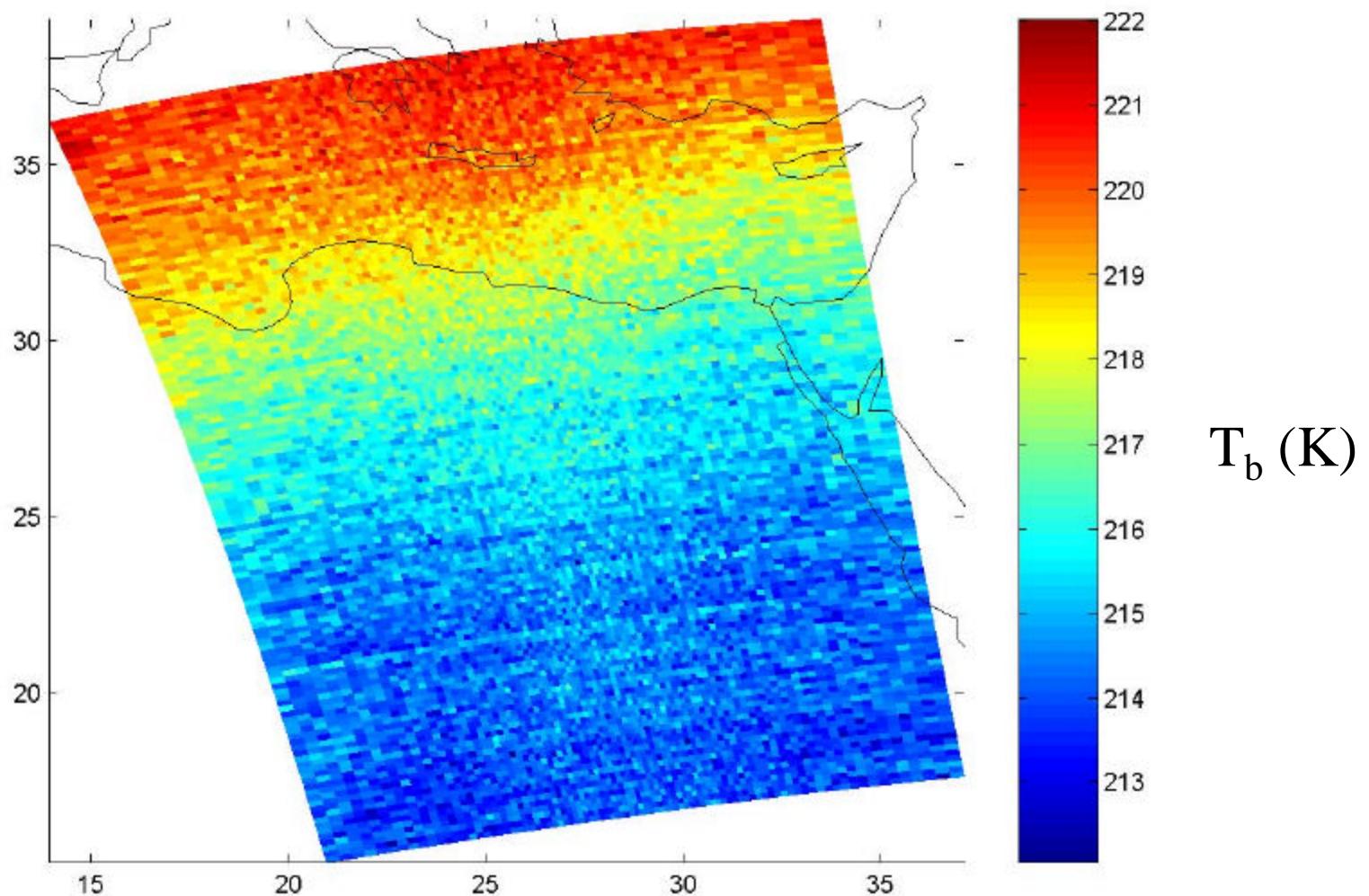
# 984.49 - 982.01 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



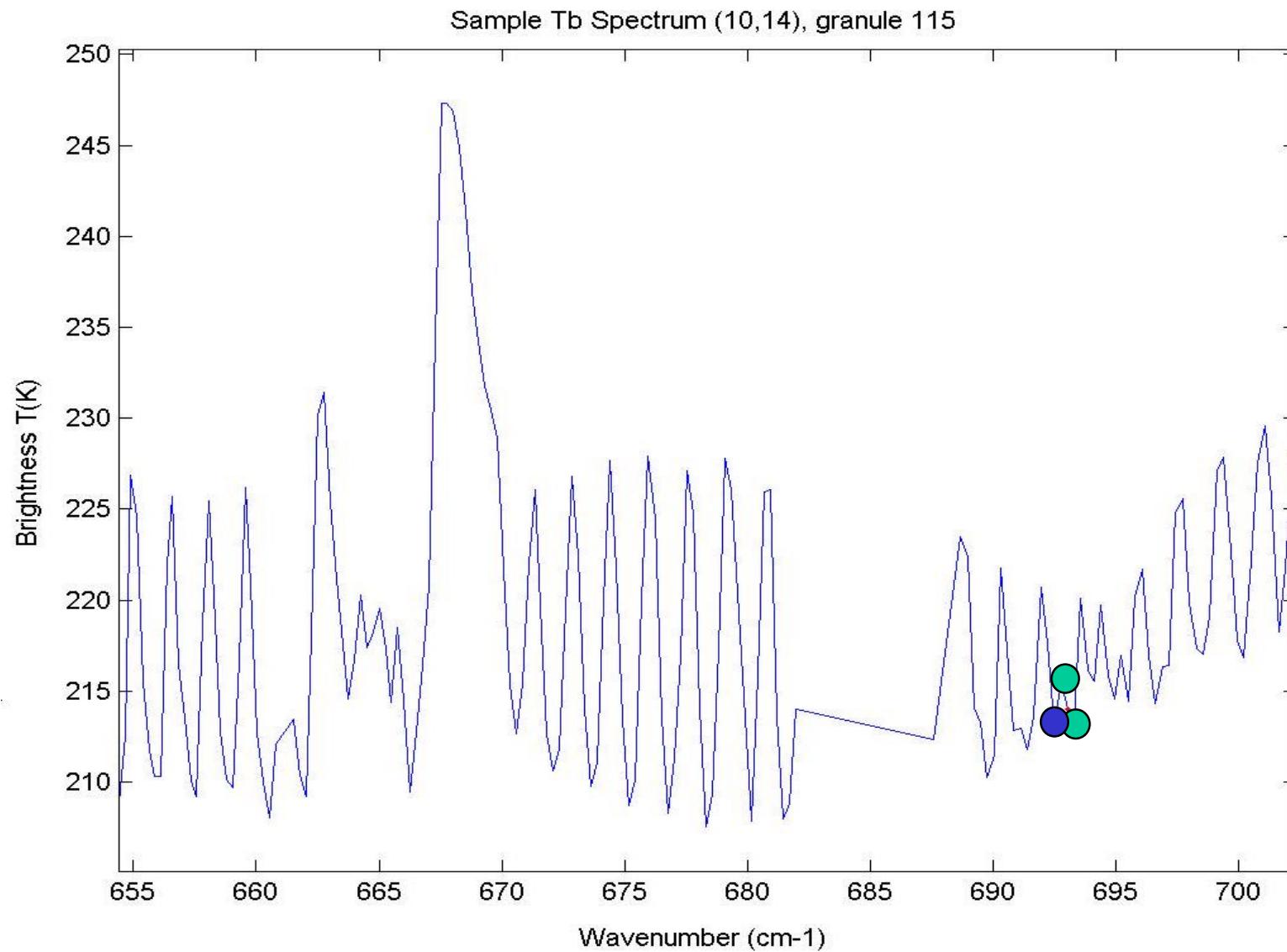
# **692.48 cm<sup>-1</sup> Brightness Temperature**

## **Granule 115, 14 June 2002**



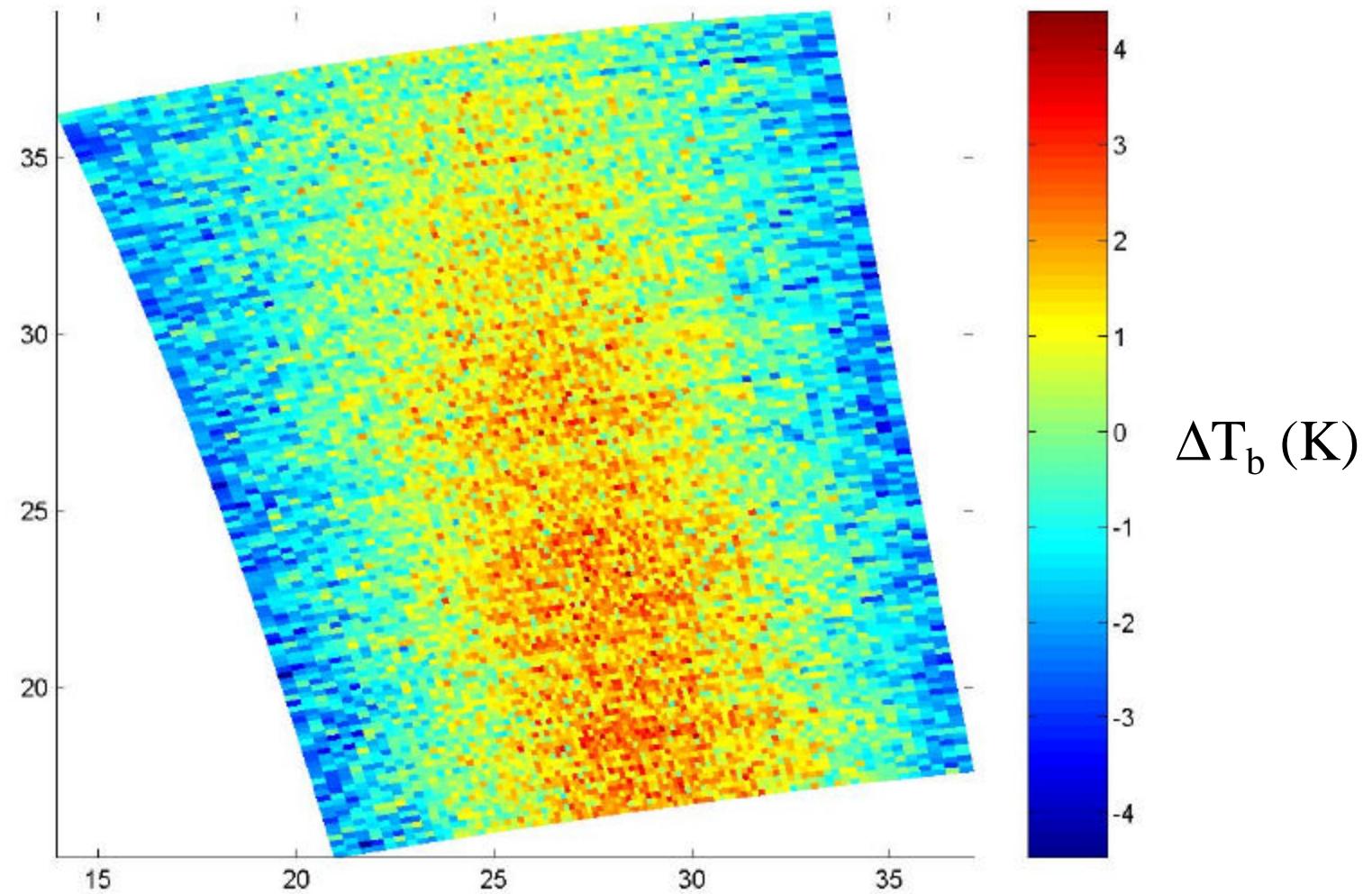
# Selected Upper Level CO<sub>2</sub> Channels

## Granule 115, 14 June 2002

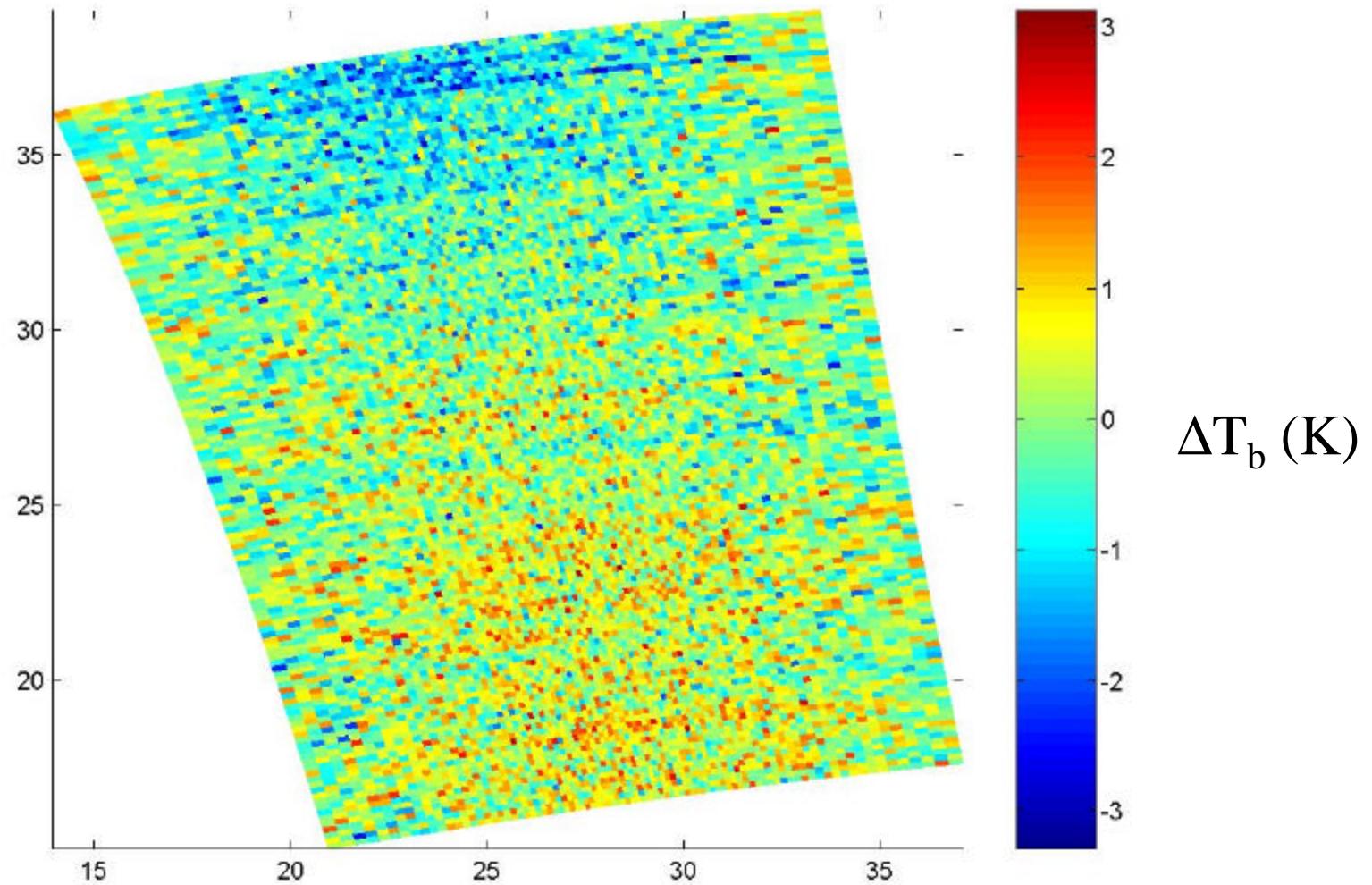


# **692.75 - 692.48 cm<sup>-1</sup> Brightness Temperature Difference**

## **Granule 115, 14 June 2002**

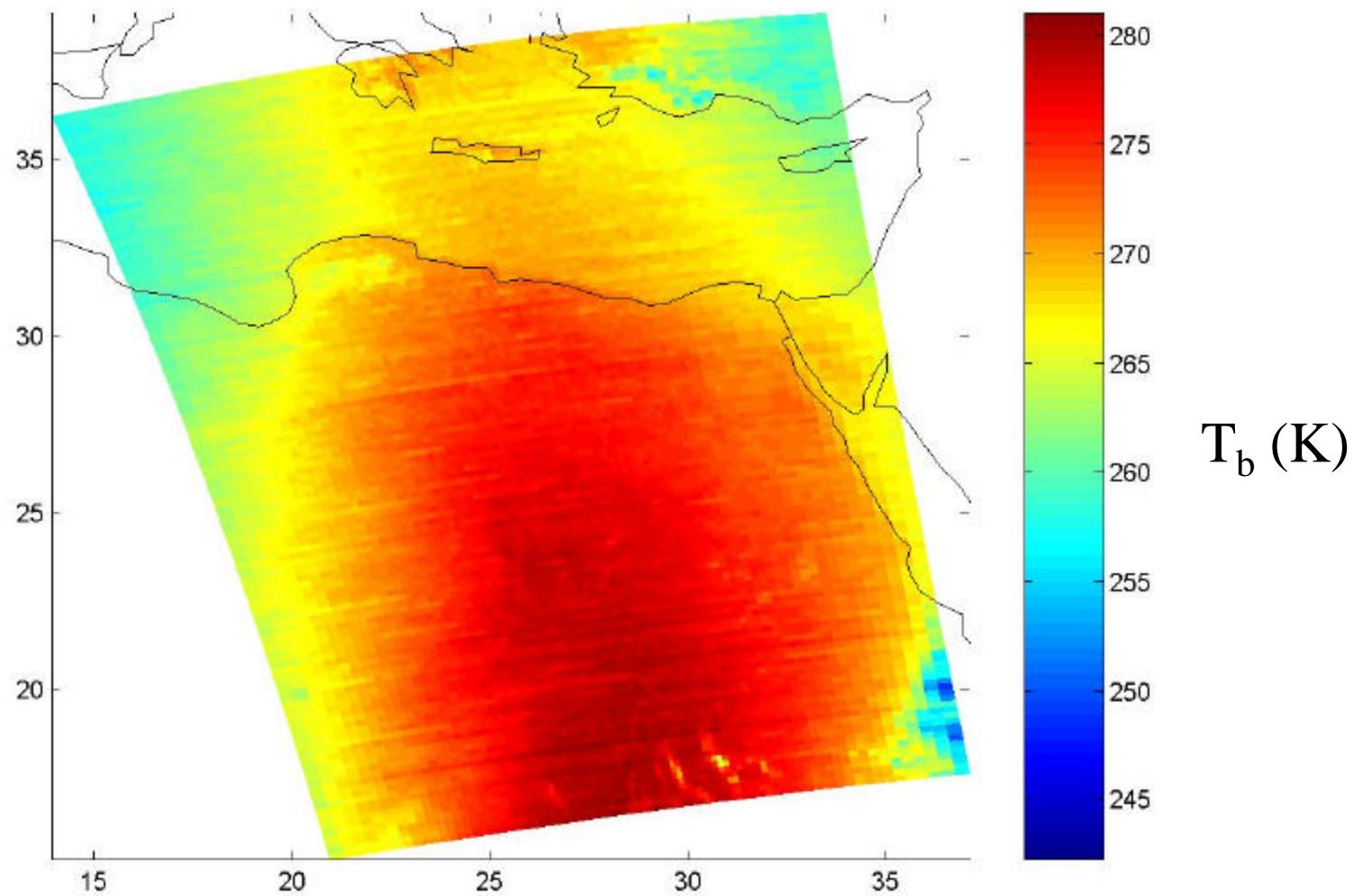


692.75 - 692.48 cm<sup>-1</sup> Difference: Limb Darkening Removed  
Granule 115, 14 June 2002



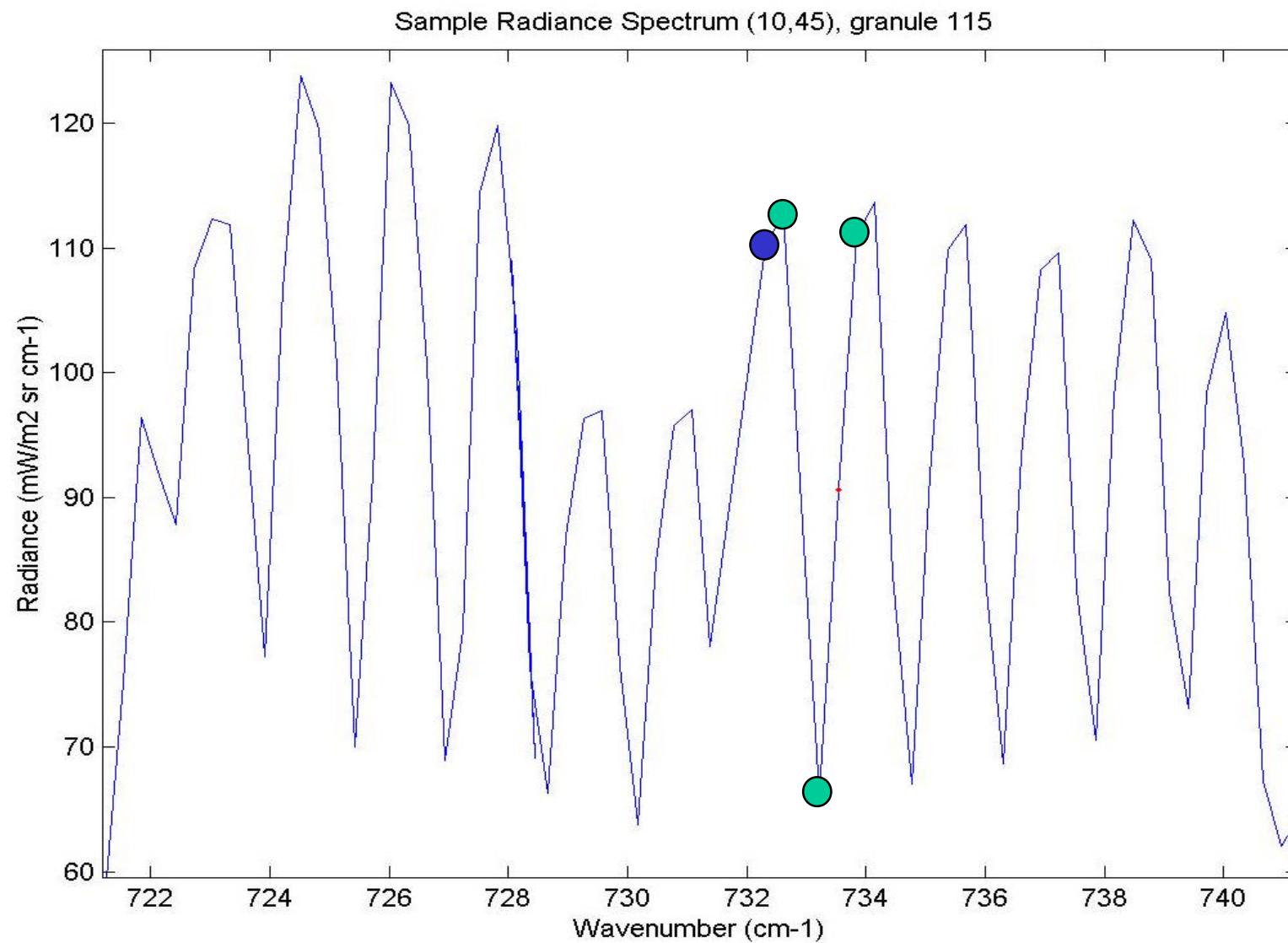
# 732.31 cm<sup>-1</sup> Brightness Temperature

## Granule 115, 14 June 2002



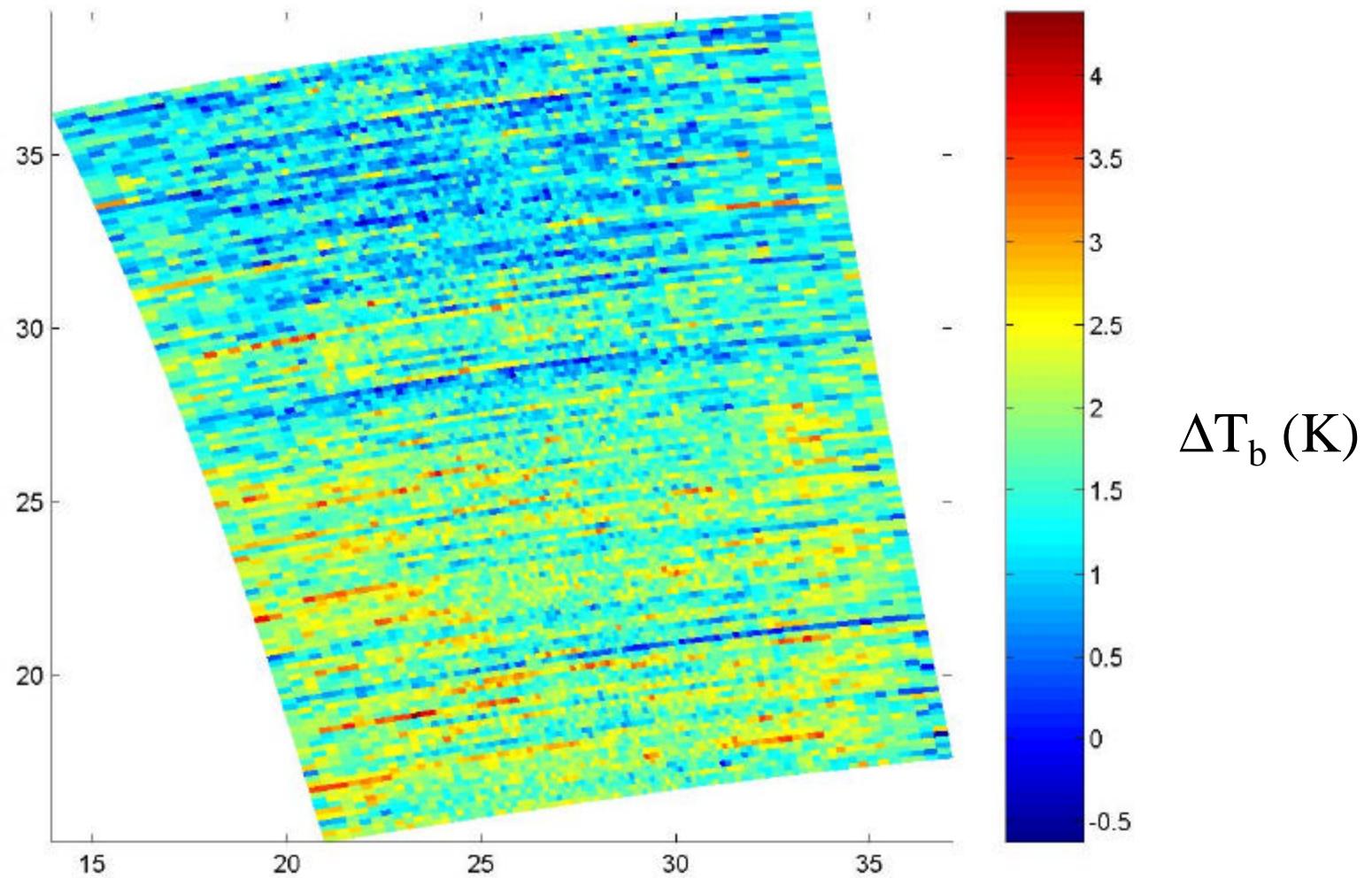
# Selected CO<sub>2</sub> Channels

## Granule 115, 14 June 2002



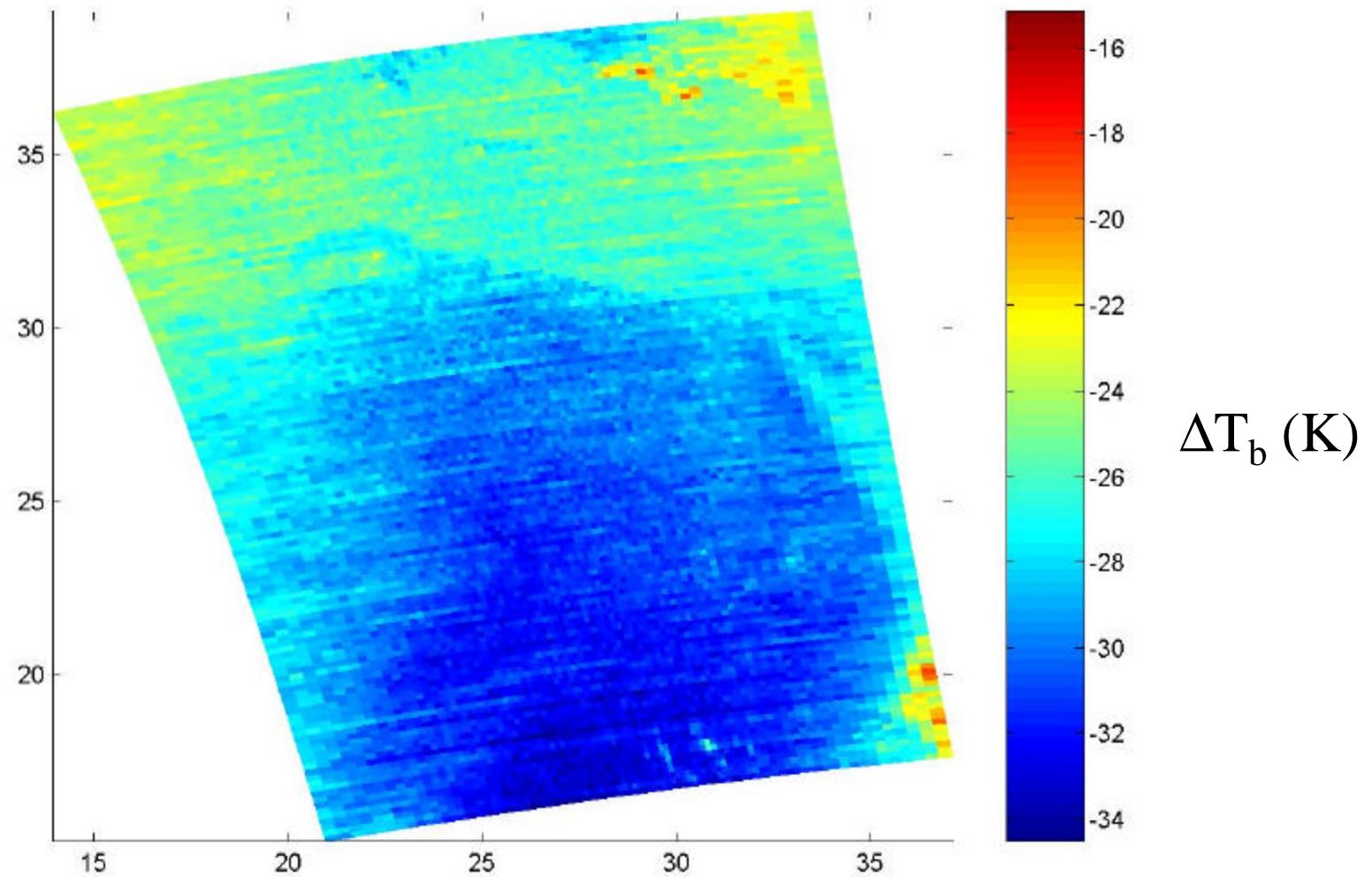
# 732.61 - 732.31 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



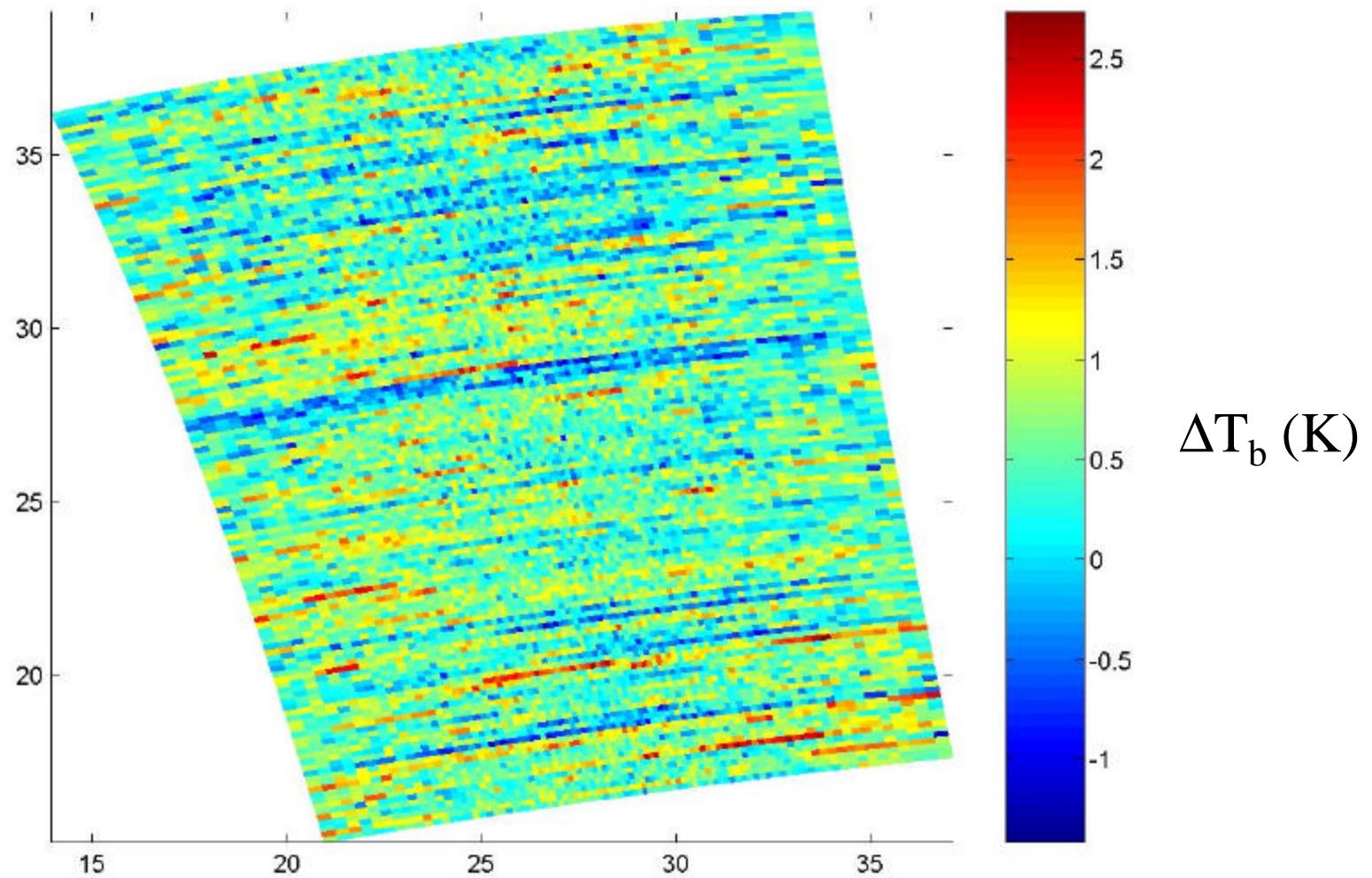
# **733.23 - 732.31 cm<sup>-1</sup> Brightness Temperature Difference**

## **Granule 115, 14 June 2002**



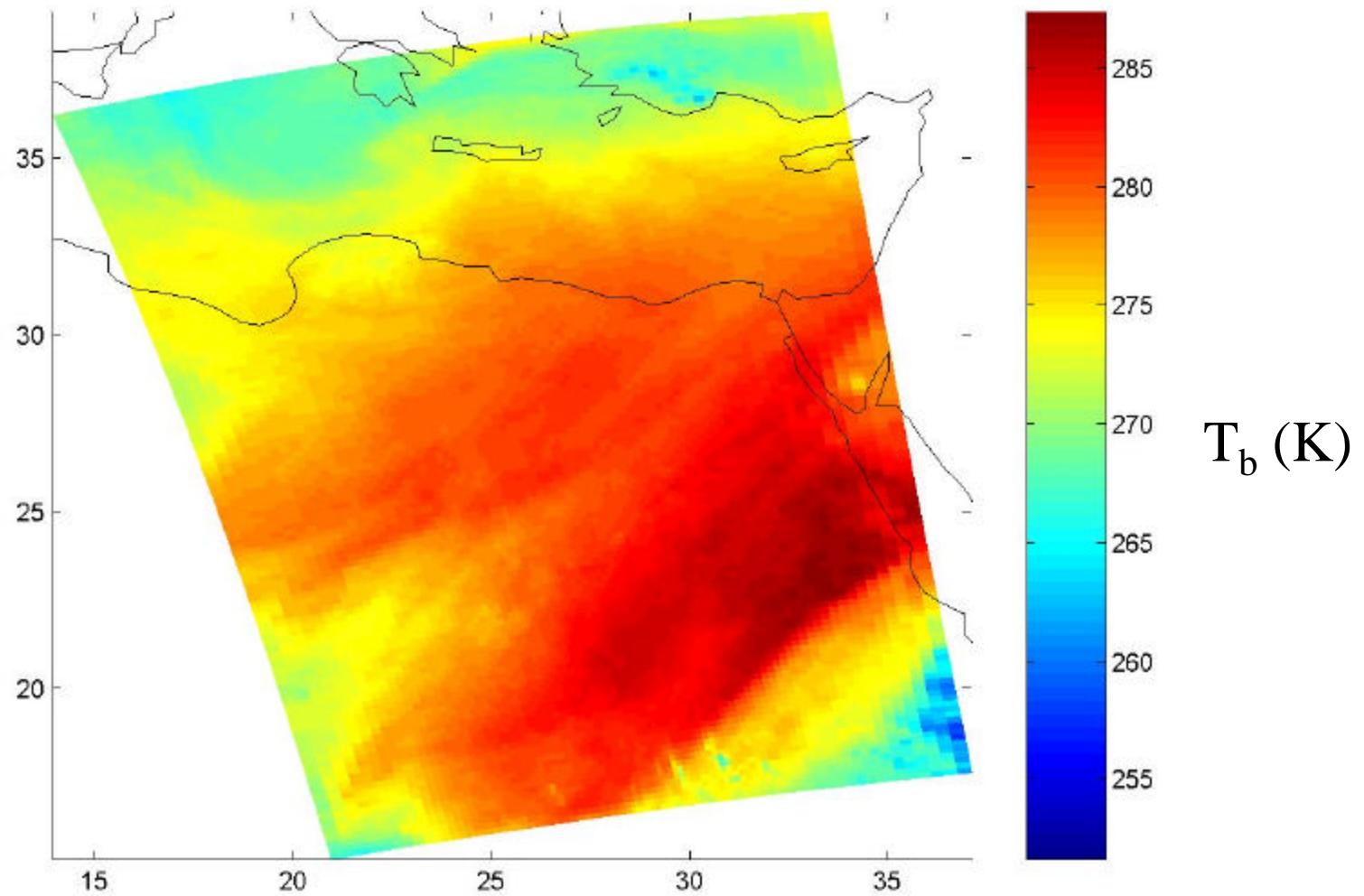
# 733.84 - 732.31 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



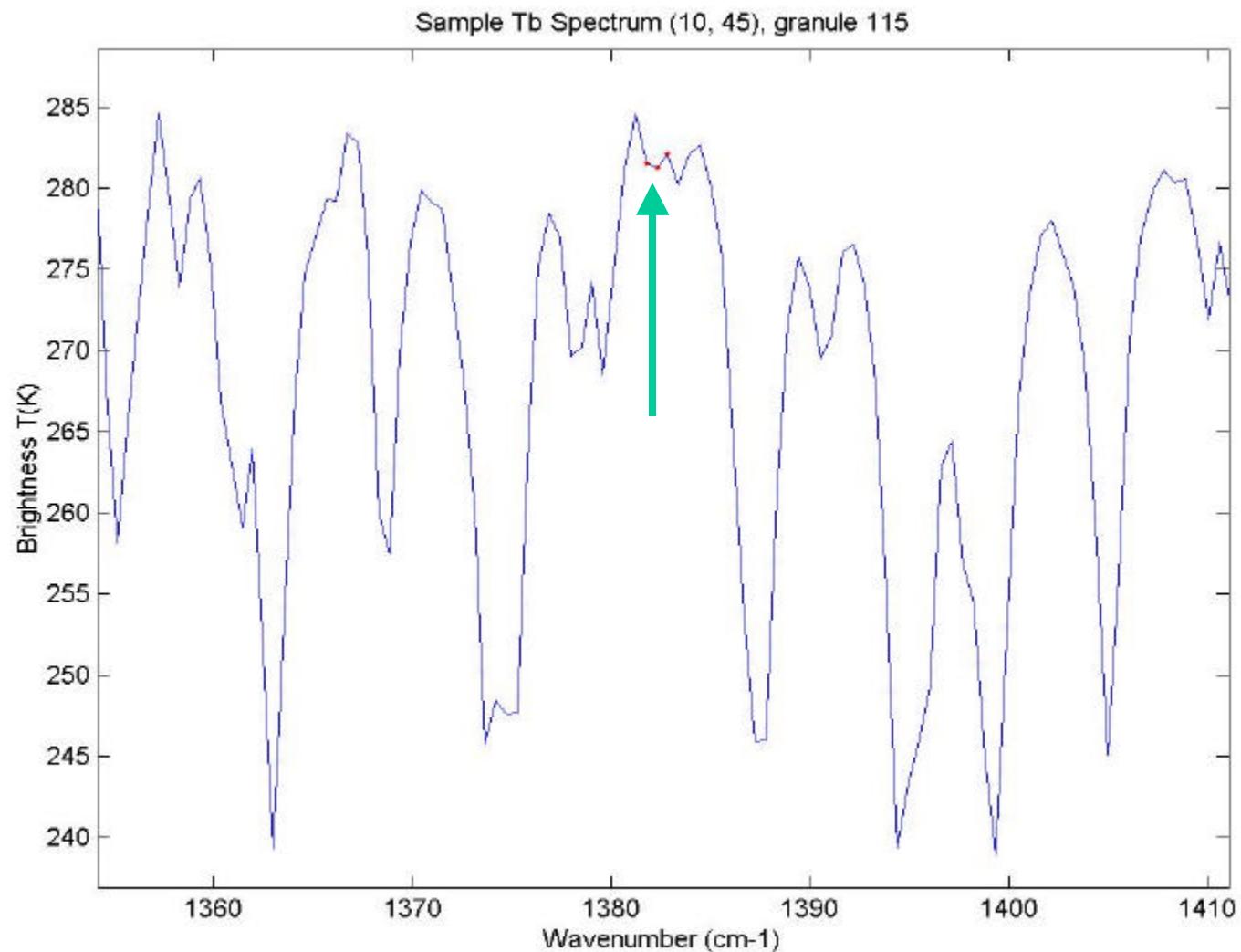
# 1381.75 cm<sup>-1</sup> Brightness Temperature

## Granule 115, 14 June 2002



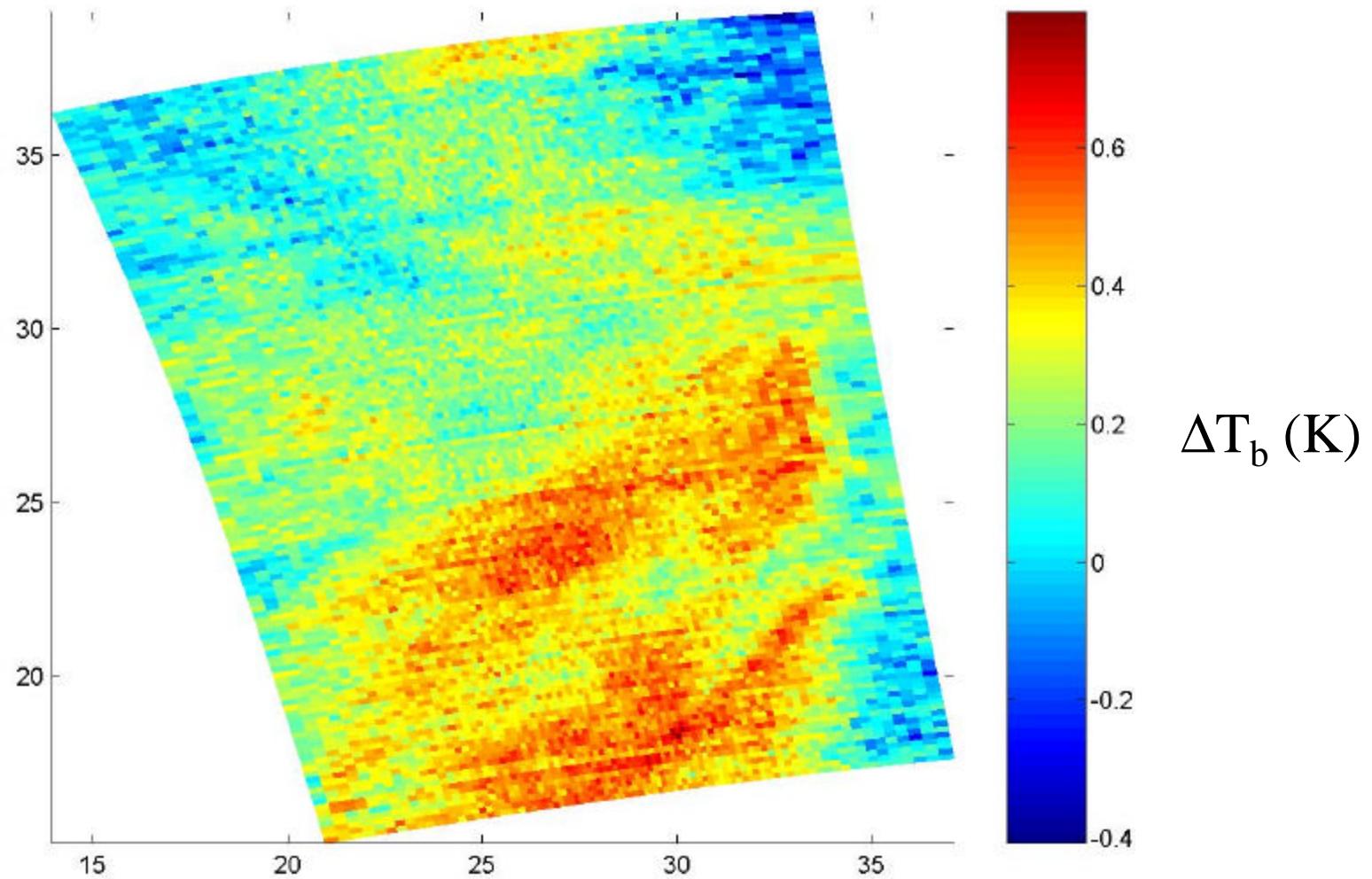
# Selected Water Vapor Channels

## Granule 115, 14 June 2002



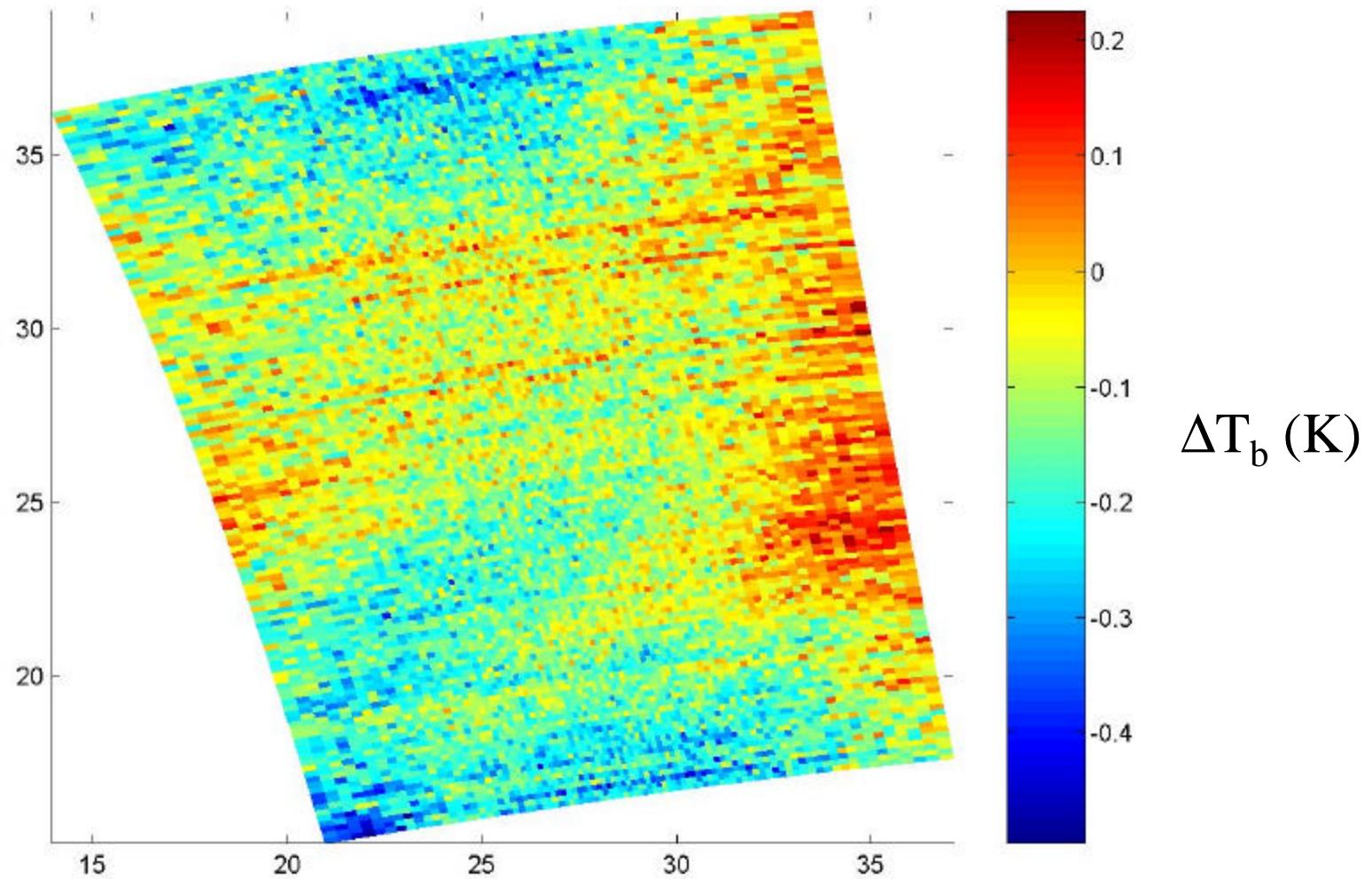
# 1382.84 - 1381.75 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



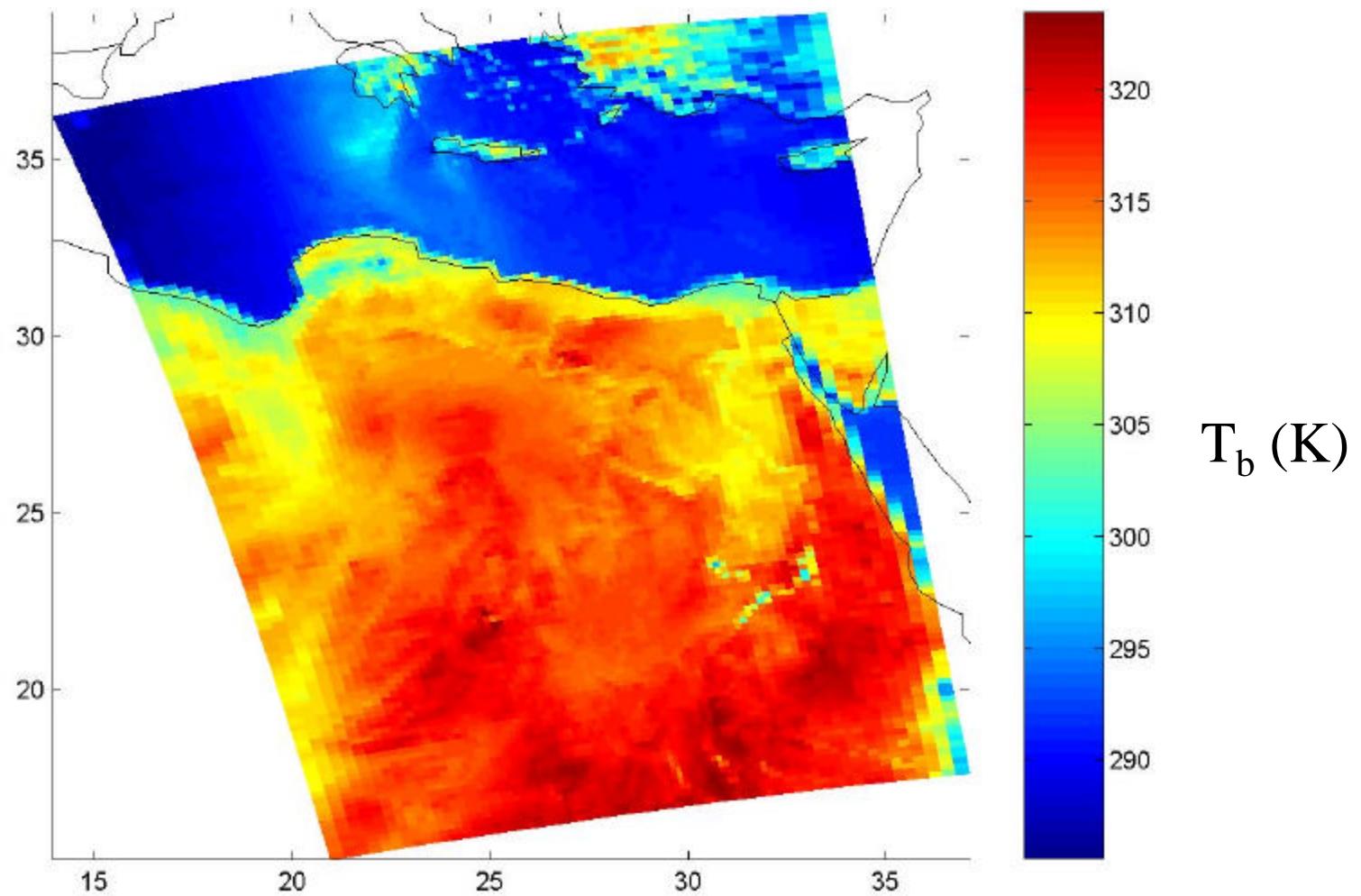
# 1382.30 - 1381.75 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



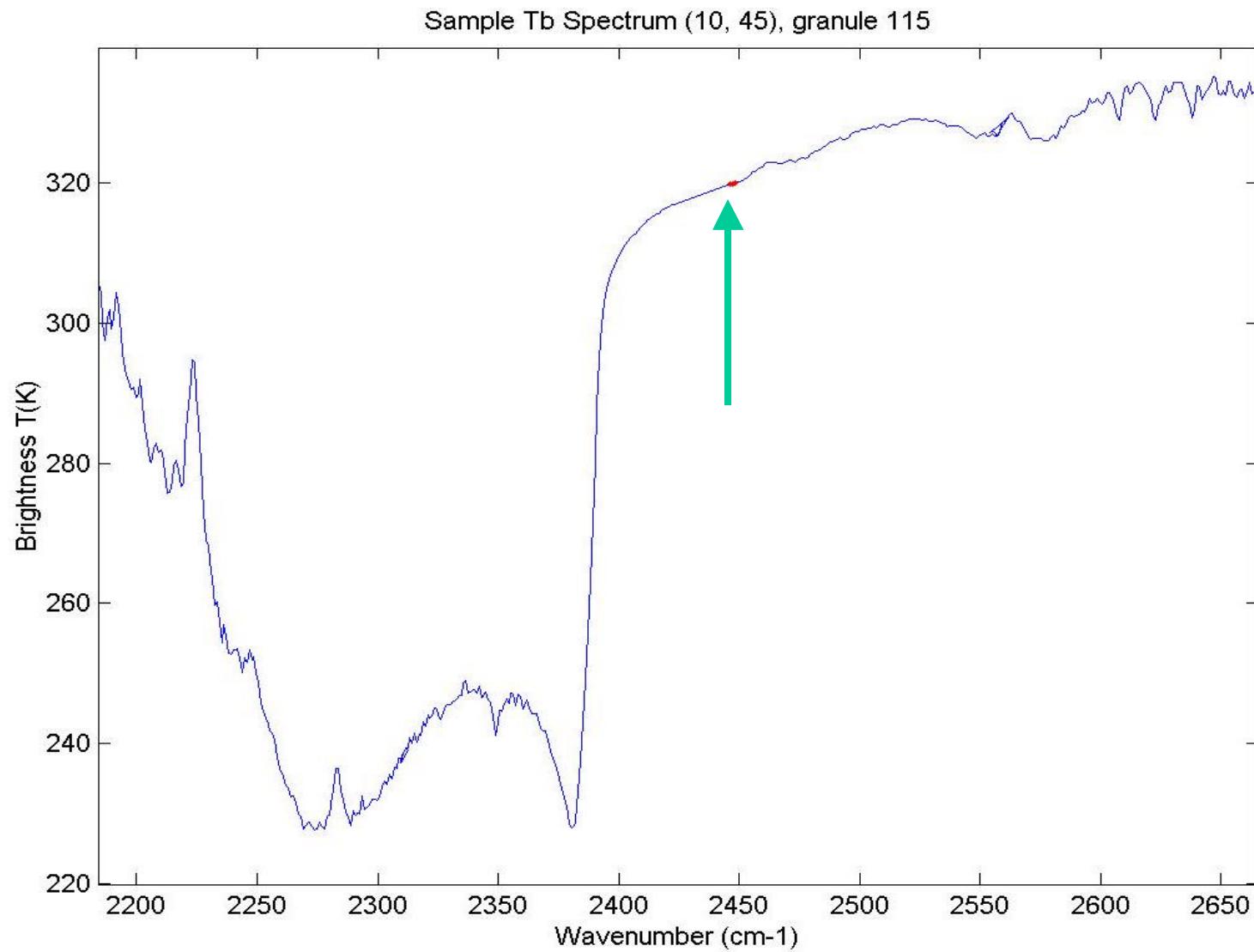
# 2446.19 cm<sup>-1</sup> Brightness Temperature

## Granule 115, 14 June 2002



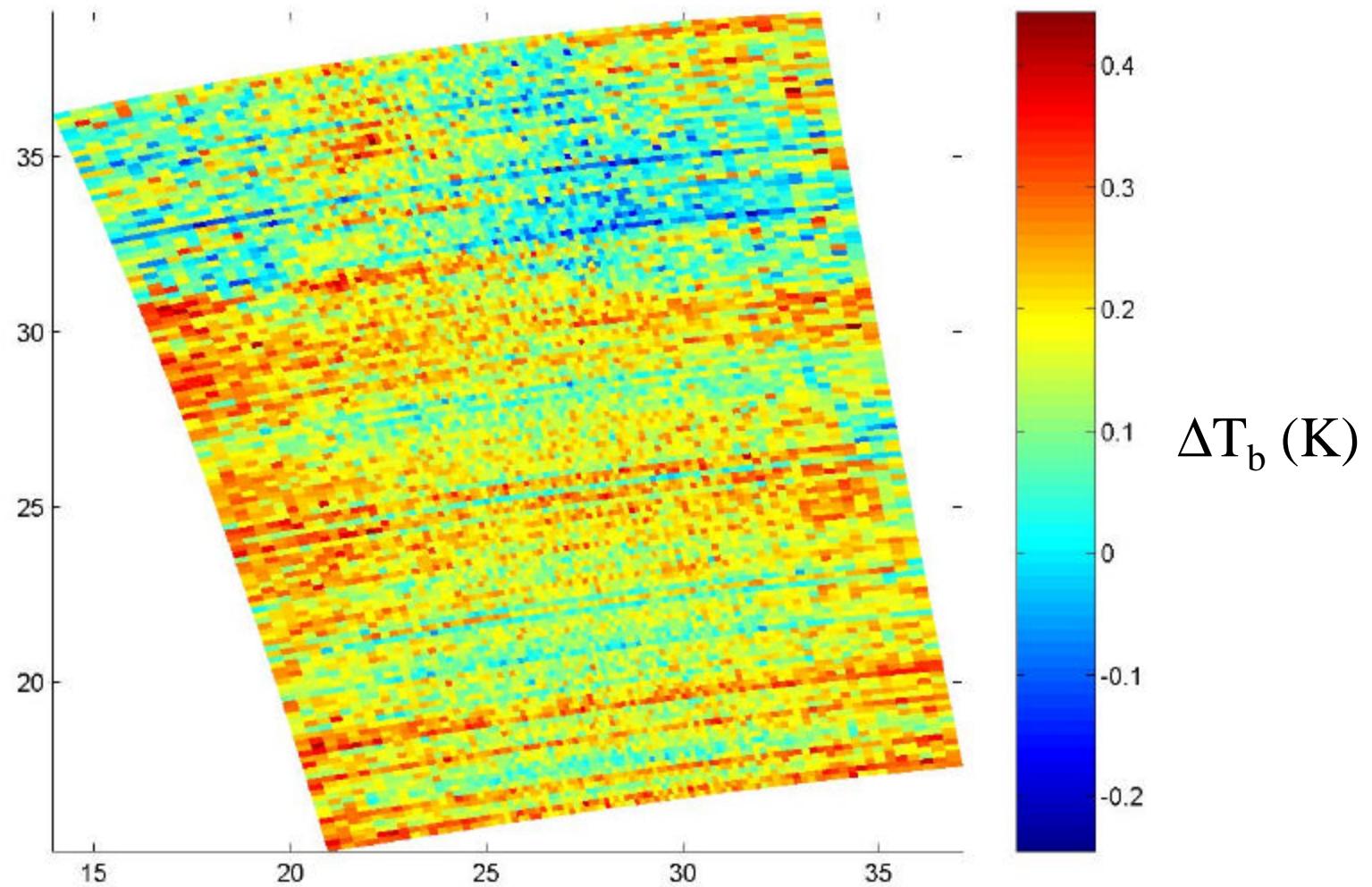
# Selected SW Window Channels

## Granule 115, 14 June 2002



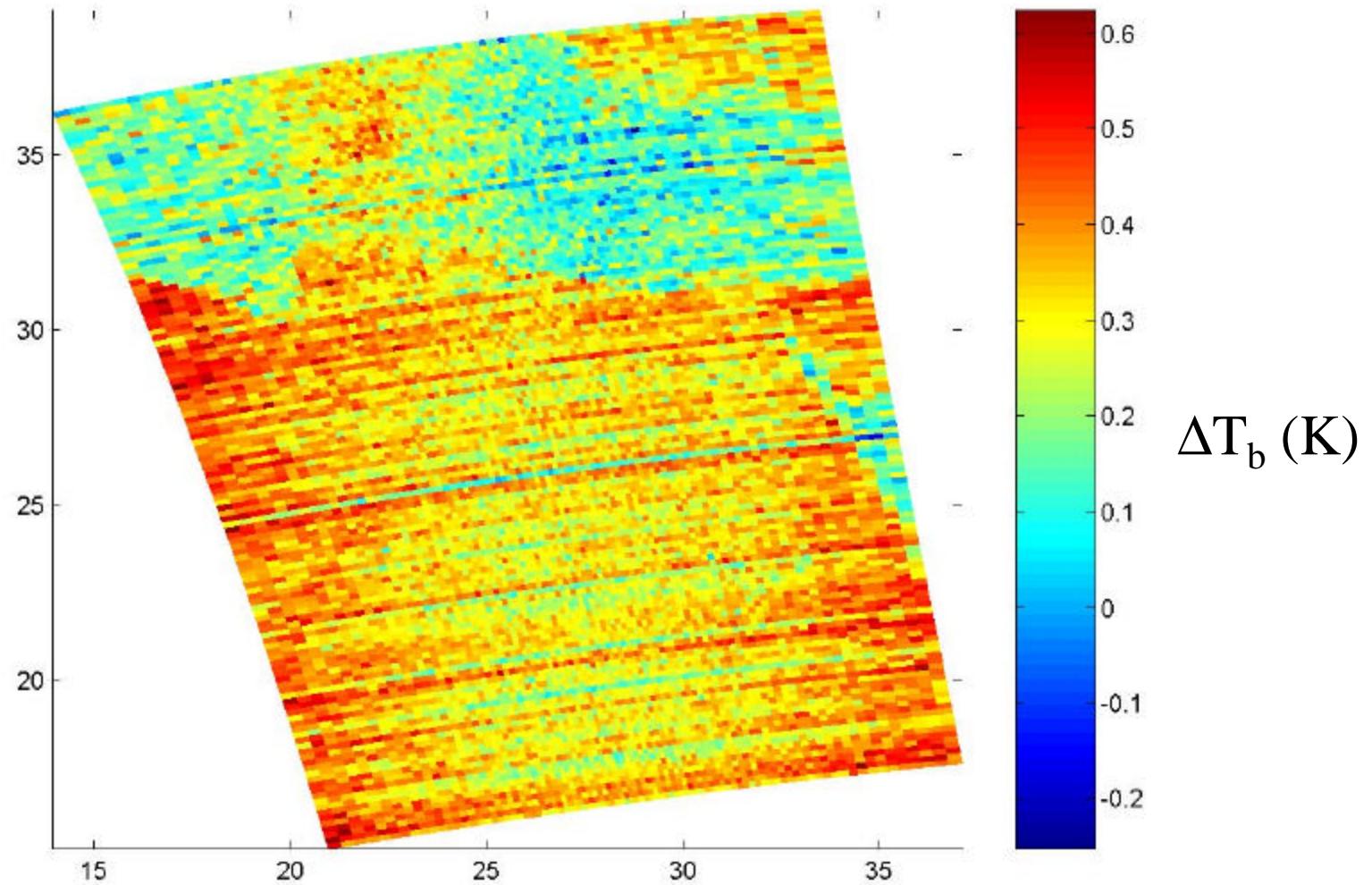
# 2447.21 - 2446.19 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



# 2448.24 - 2446.19 cm<sup>-1</sup> Brightness Temperature Difference

## Granule 115, 14 June 2002



# **Conclusion: Striping or 1/f -noise**

- ◆ This type of calibration error or t-correlated noise needs to be characterized
- ◆ It is quite small (0.1-0.3 K) for the shortwave window region ( $2446\text{ cm}^{-1}$ )
- ◆ Also, order 0.2 K at  $1382\text{ cm}^{-1}$  water vapor channels
- ◆ Considerably larger (0.5-2.0 K) for longwave window ( $982\text{ cm}^{-1}$ ) & CO<sub>2</sub> band ( $692$  &  $732\text{ cm}^{-1}$ )
- ◆ Expect effect on temperature retrievals

# Obs-Calcs using PREPQC

- **Goal**

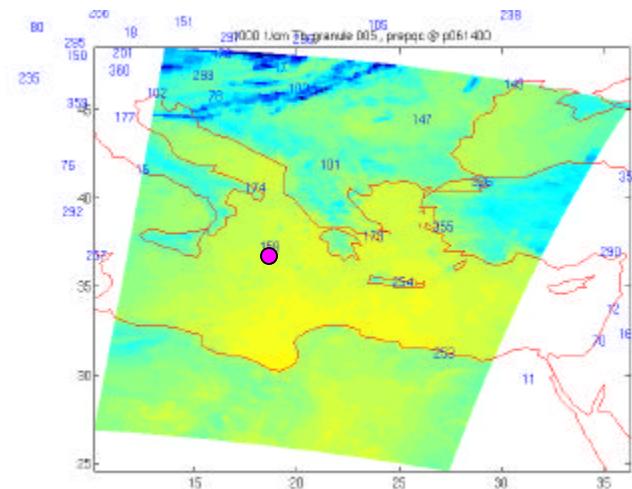
Early spectral calibration evaluation and early radiance evaluation of mid-tropospheric channels. Monitoring of spectral behavior during transient cool down periods. Forward model evaluation.

- **Approach using PREPQC and focus granule data:**

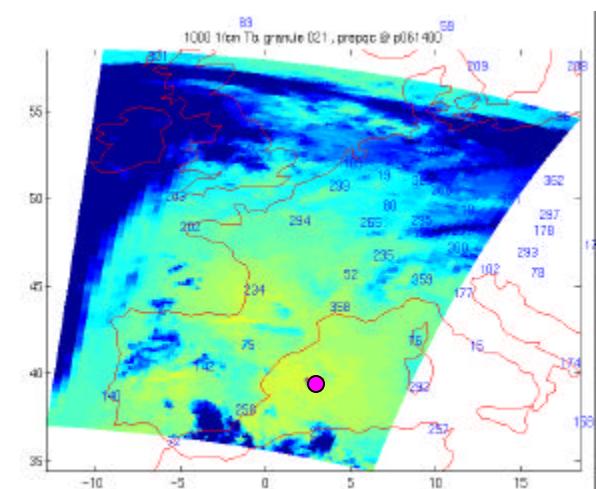
- create “home-made” matchups. Over-water cases - one each from granules 005, 021, 115, 116 and 236.
- determine  $T_{\text{skin}}$  from AIRS obs using  $2616 \text{ cm}^{-1}$  (nighttime) and  $900 \text{ cm}^{-1}$  (daytime) channels and ocean emissivity
- supplement PREPQC profiles (above sonde, other gases) with AFGL US Standard atmosphere. 370 ppmv  $\text{CO}_2$ .
- run SARTA\_m16. run kCARTA and LBLRTM and convolve w/srftables\_061402v1.hdf

# 5 Matchups:

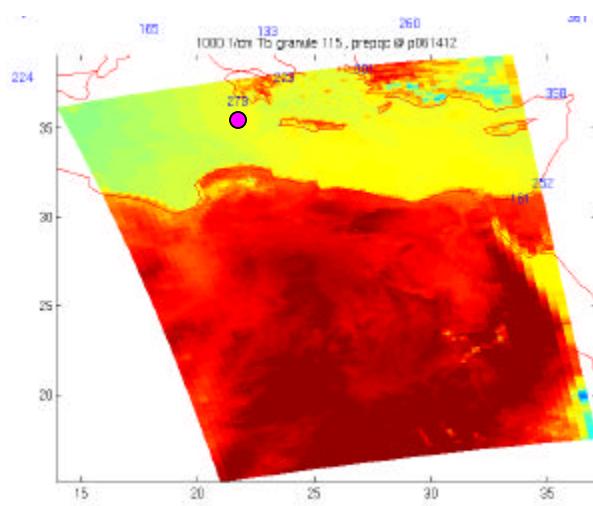
005



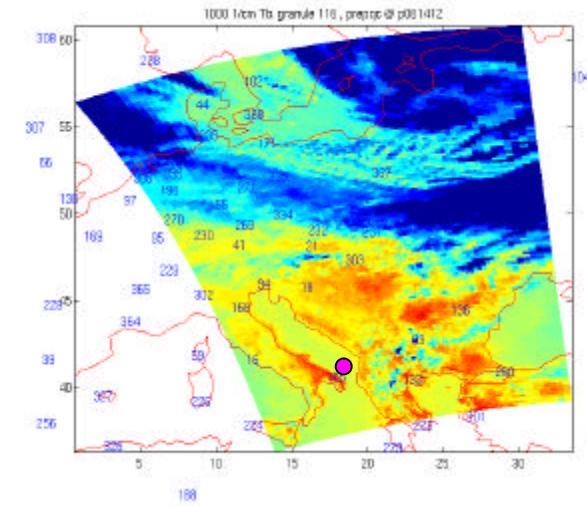
021



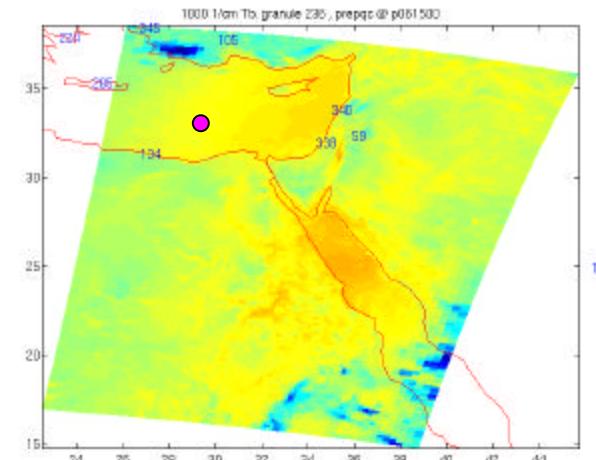
115



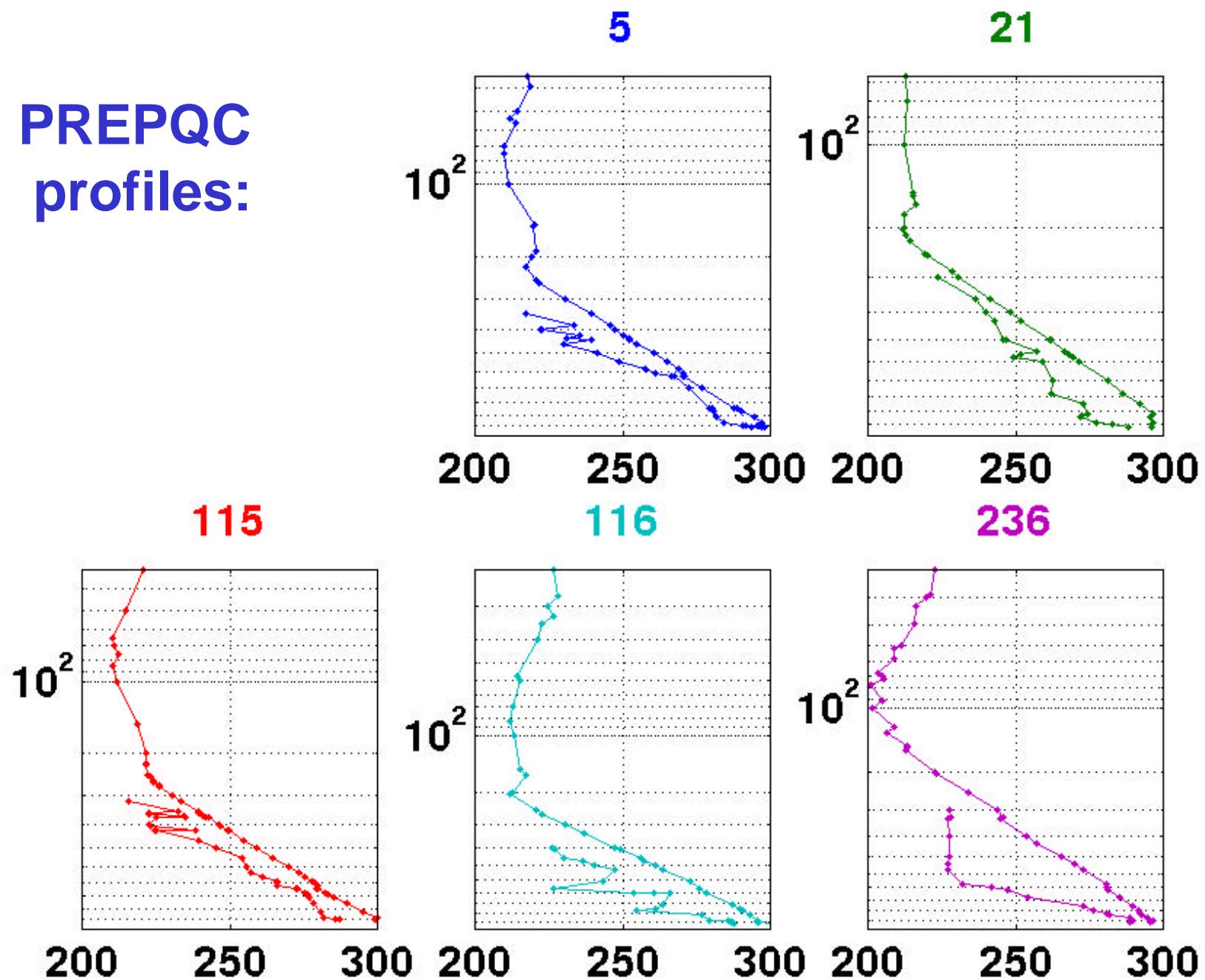
116



236



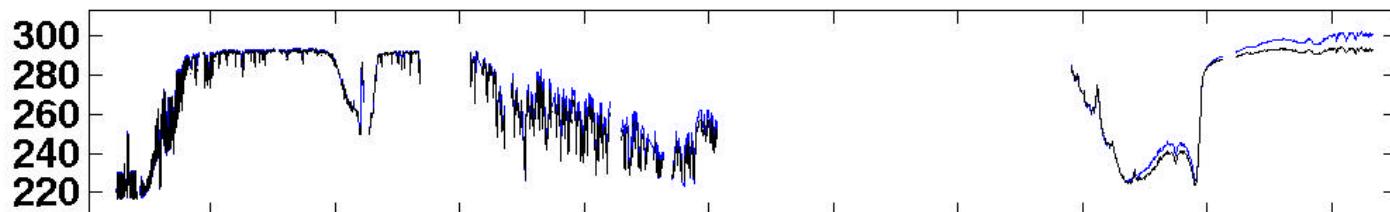
## PREPQC profiles:



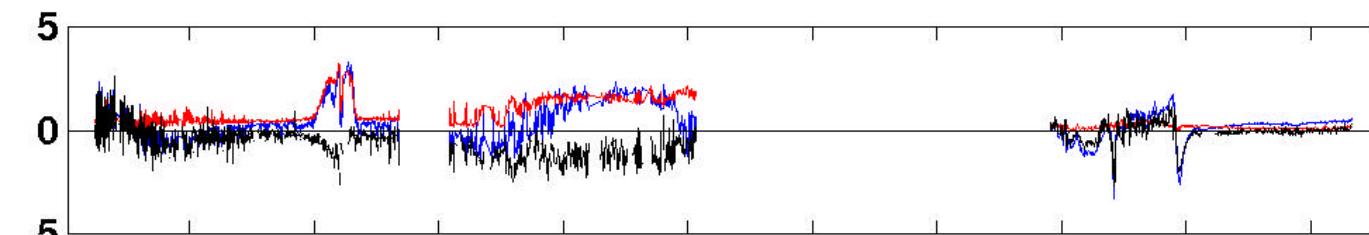
# Obs-Calcs using PREPQC

PREPQC mean  
PREPQC rms  
ECMWF case

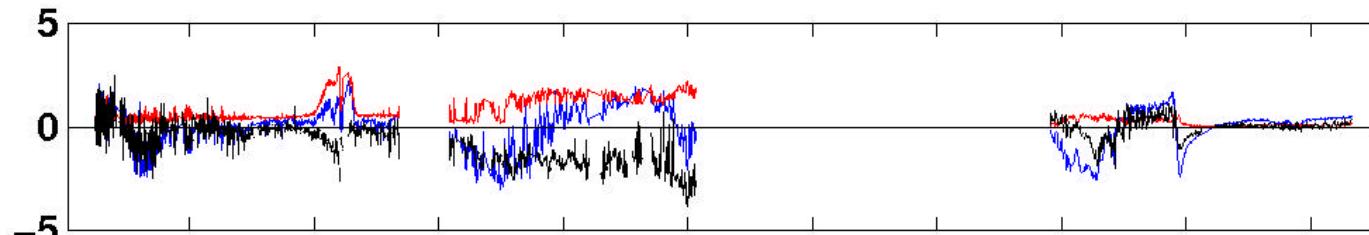
AIRS Tb



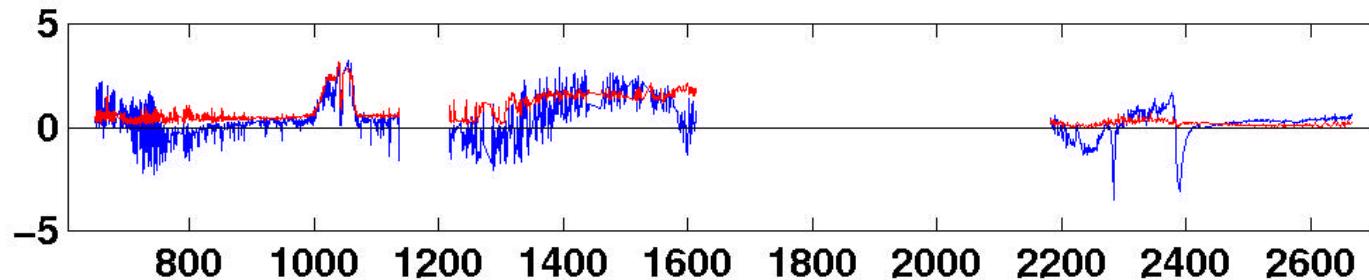
AIRS-Calc:



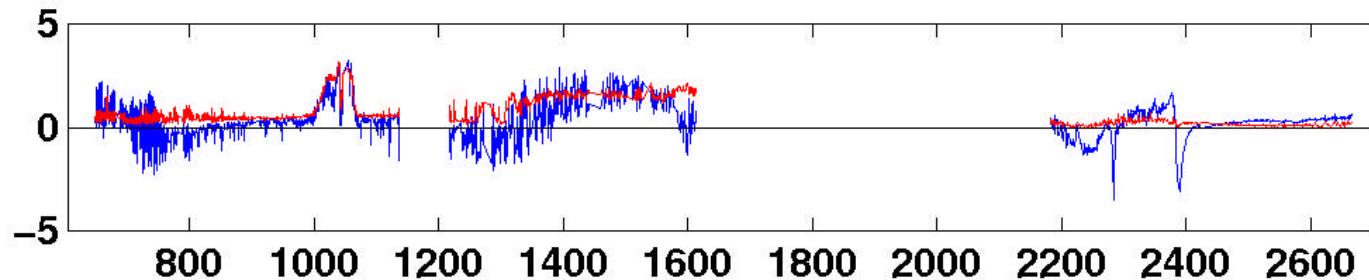
kCARTA



LBLRTM



SARTA\_m16

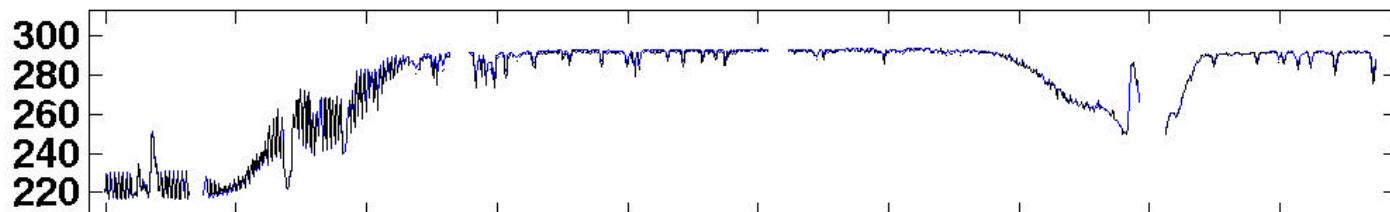


\* black curve is a granule 005 case with ECMWF profile input

# Obs-Calcs using PREPQC

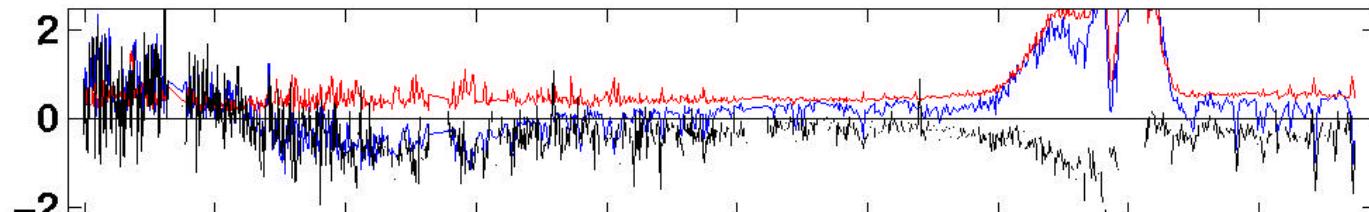
PREPQC mean  
PREPQC rms  
ECMWF case

AIRS Tb

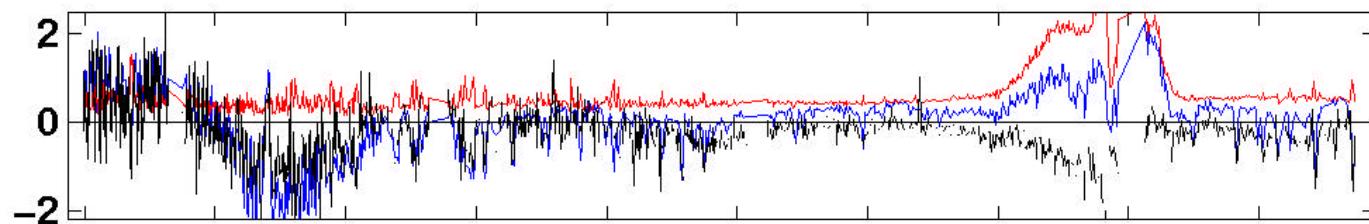


AIRS-Calc:

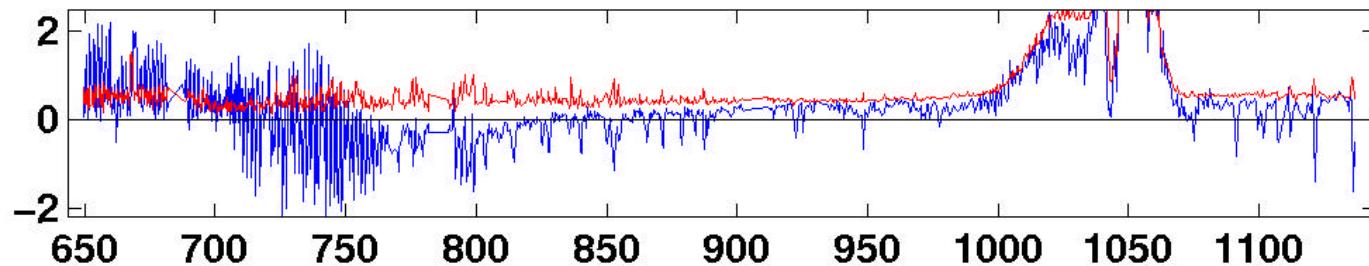
kCARTA



LBLRTM



SARTA\_m16

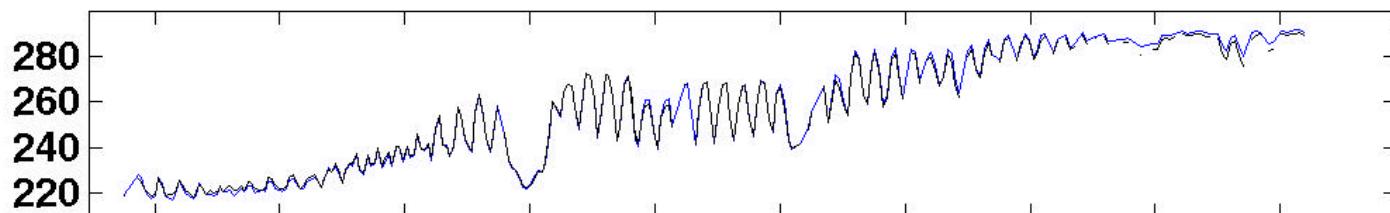


\* black curve is a granule 005 case with ECMWF profile input

# Obs-Calcs using PREPQC

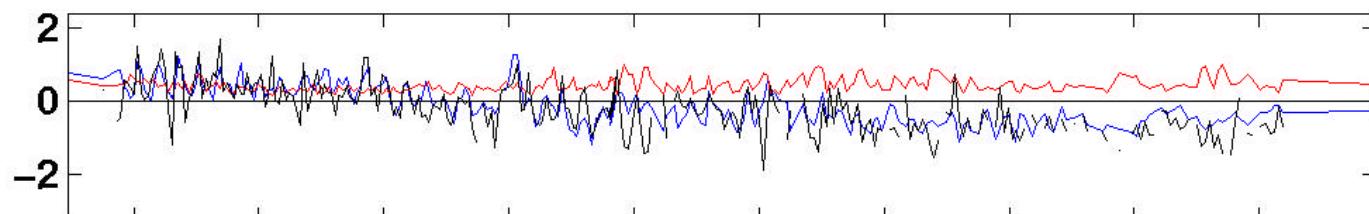
- PREPQC mean
- PREPQC rms
- ECMWF case

AIRS Tb

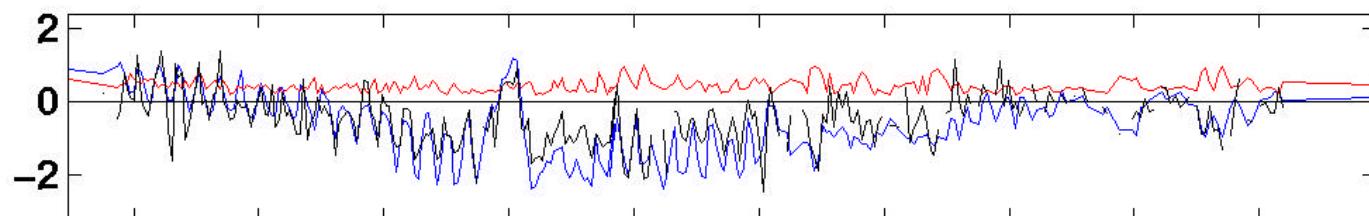


AIRS-Calc:

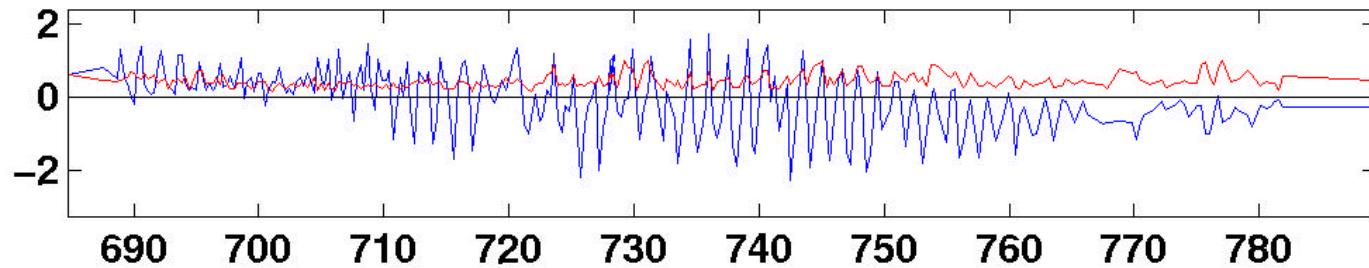
kCARTA



LBLRTM



SARTA\_m16

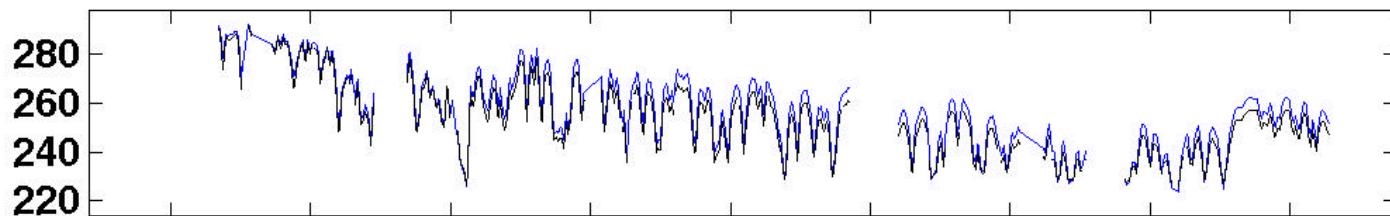


\* black curve is a granule 005 case with ECMWF profile input

# Obs-Calcs using PREPQC

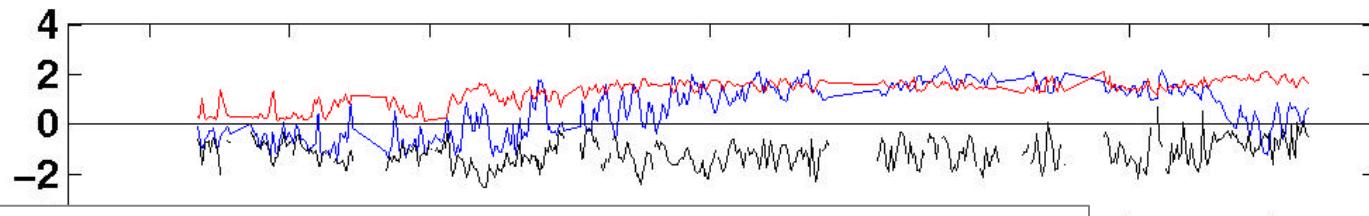
PREPQC mean  
PREPQC rms  
ECMWF case

AIRS Tb

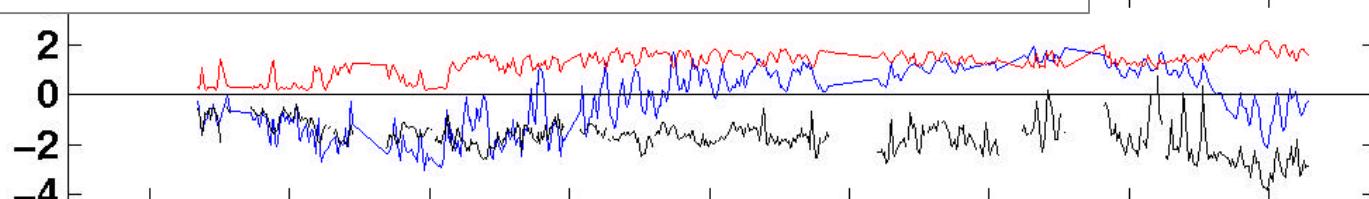


AIRS-Calc:

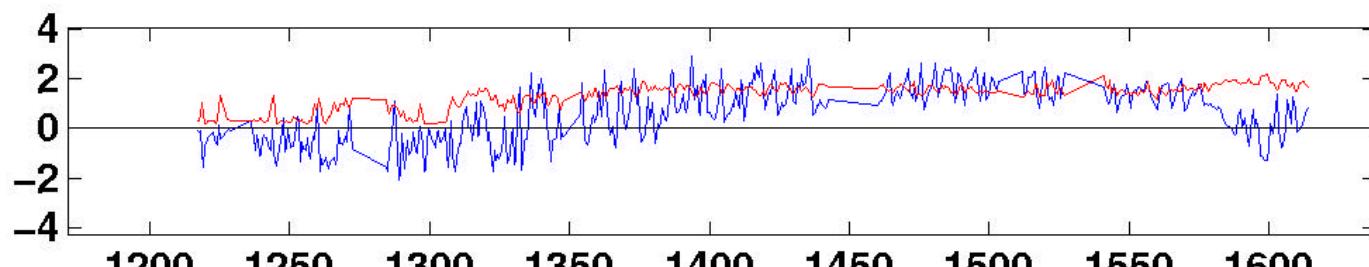
kCARTA



LBLRTM



SARTA\_m16

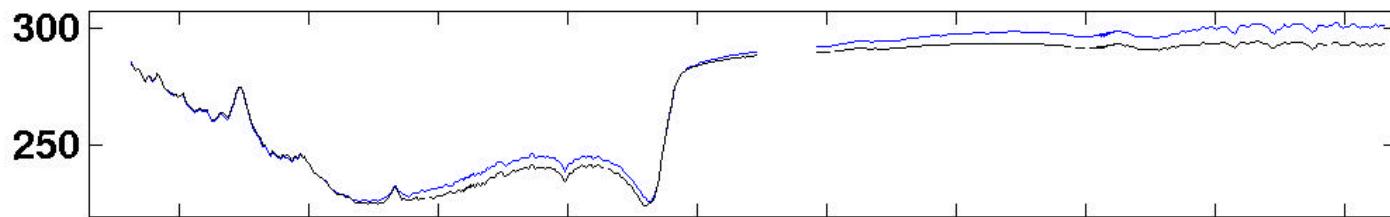


\* black curve is a granule 005 case with ECMWF profile input

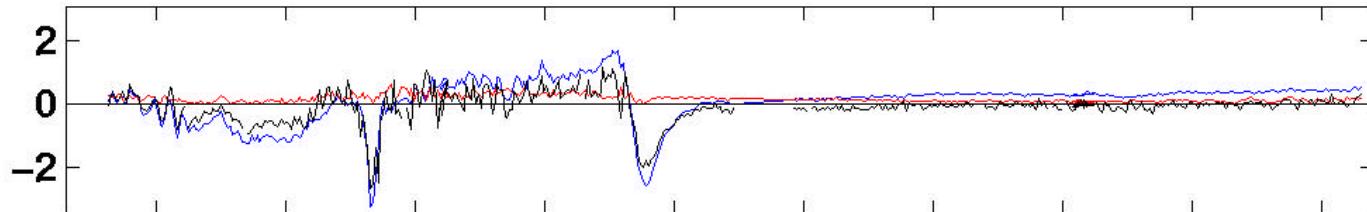
# Obs-Calcs using PREPQC

- PREPQC mean
- PREPQC rms
- ECMWF case

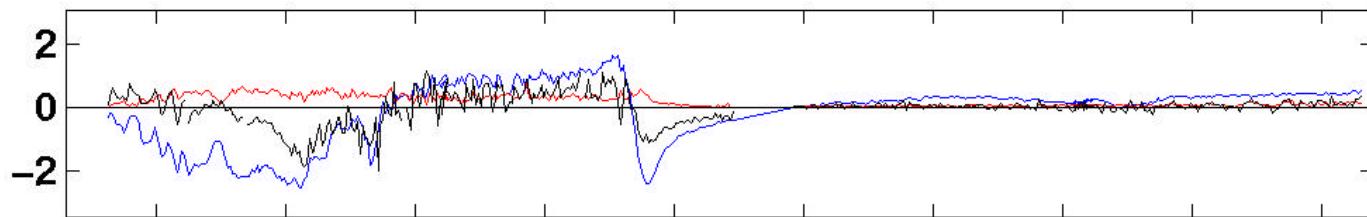
AIRS Tb



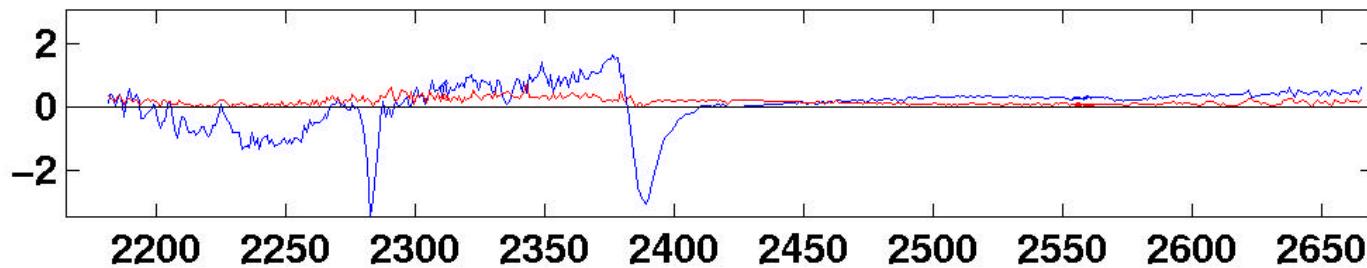
AIRS-Calc:



LBLRTM



SARTA\_m16

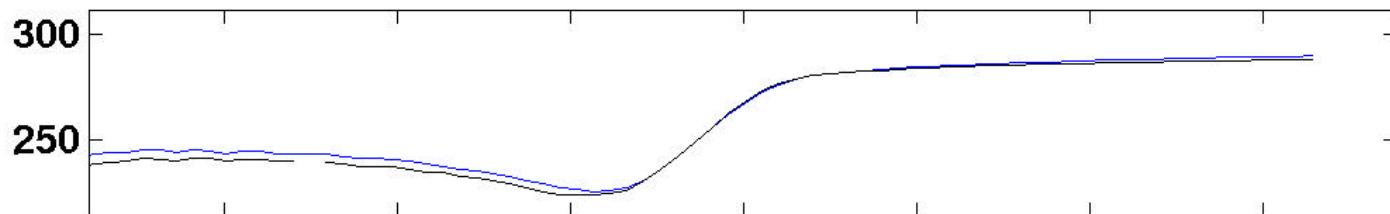


\* black curve is a granule 005 case with ECMWF profile input

# Obs-Calcs using PREPQC

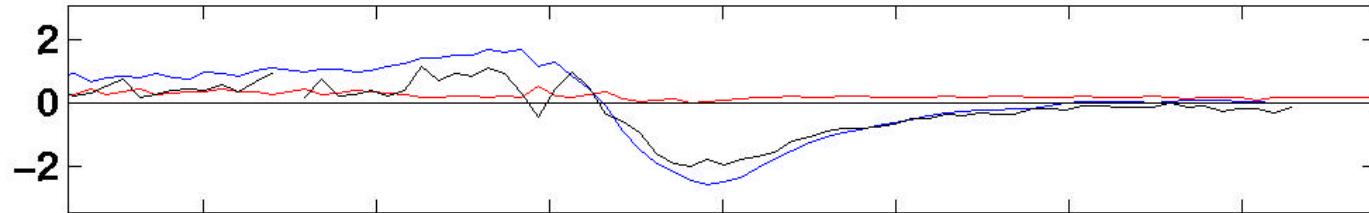
PREPQC mean  
PREPQC rms  
ECMWF case

AIRS Tb

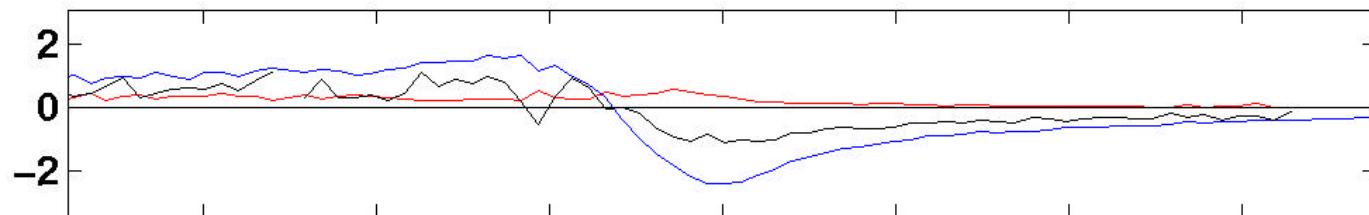


AIRS-Calc:

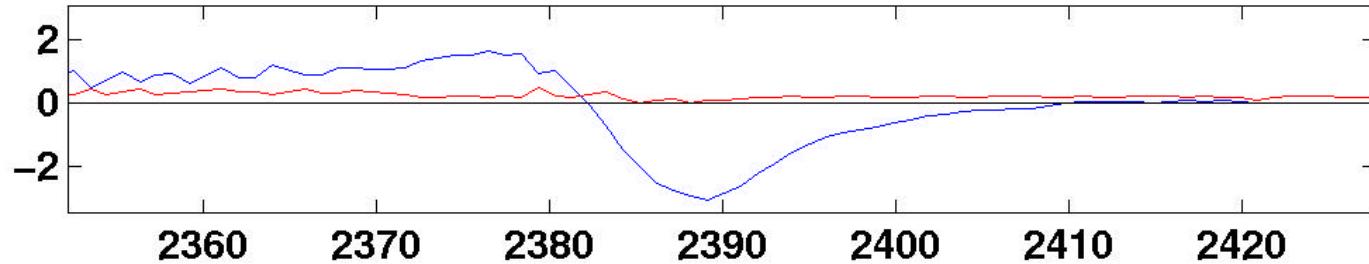
kCARTA



LBLRTM



SARTA\_m16



\* black curve is a granule 005 case with ECMWF profile input

# Obs-Calcs using PREPQC

- **Summary:**

- Overall, results look very good !
- PREPQC-based obs-calcs look similar in nature to previous results, with the exception of the 4.3 $\mu$ m band-head region.
- PREPQC-based obs-calcs similar to ECMWF based obs-calcs, except for water vapor channels
- LBLRTM / kCARTA obs-calc differences consistent with expectations. kCARTA 15um CO<sub>2</sub> lineshape yields improves obs-calcs.
- SARTA\_m16 is off by ~3.5 $\mu$ m on 6/14. Largest errors (up to ~2K) w/r/t correct frequency set in 700-770 1/cm region.
- Water band residuals similar to previous results using operational radiosondes
- kCARTA's new H<sub>2</sub>O continuum looks better at  $\nu_2$  band center

- **Next:**

- more cases and better atmospheric profile characterization ...

# **Broadband radiance evaluation using Geo's**

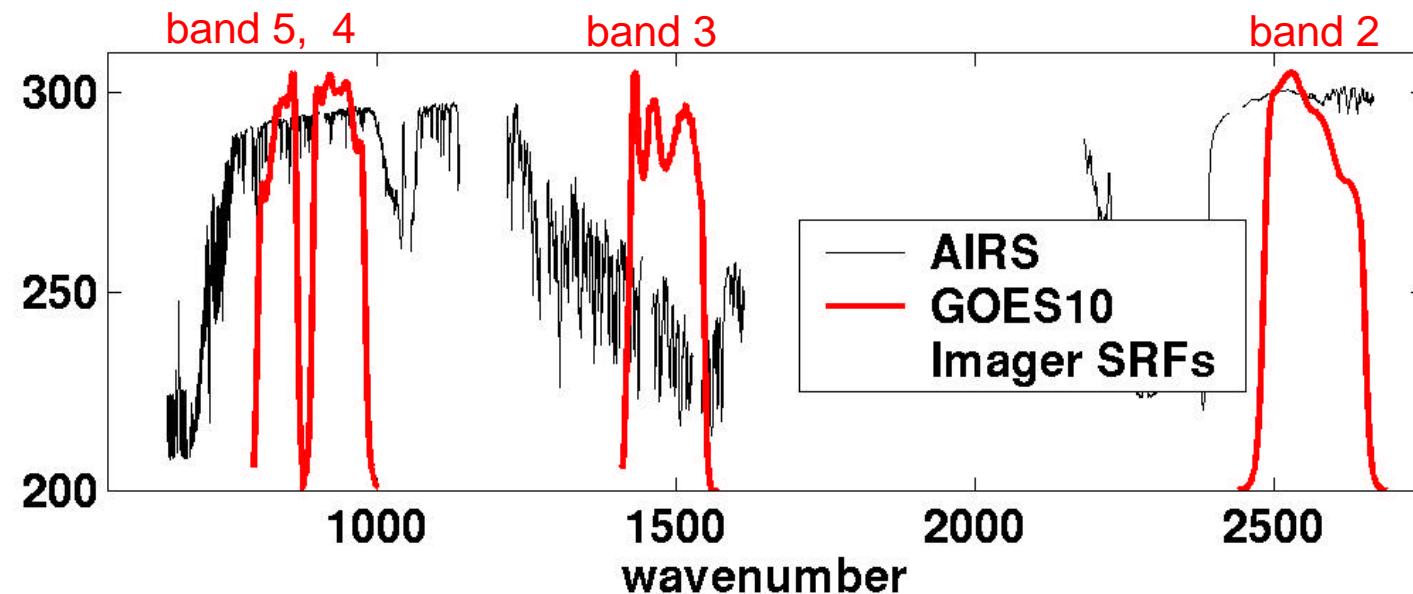
- **Goal**

Early radiance evaluation, broadband

- **Approach using GOES-10 and focus granule data**

- convolve spectra from AIRS granules 089 and 212 with GOES-10 Imager SRFs
- interpolate AIRS and GOES-10 observations to a common spatial grid
- make comparisons *at GOES-10 sub-satellite point*

# Convolving AIRS with GOES-10 Imager SRFs

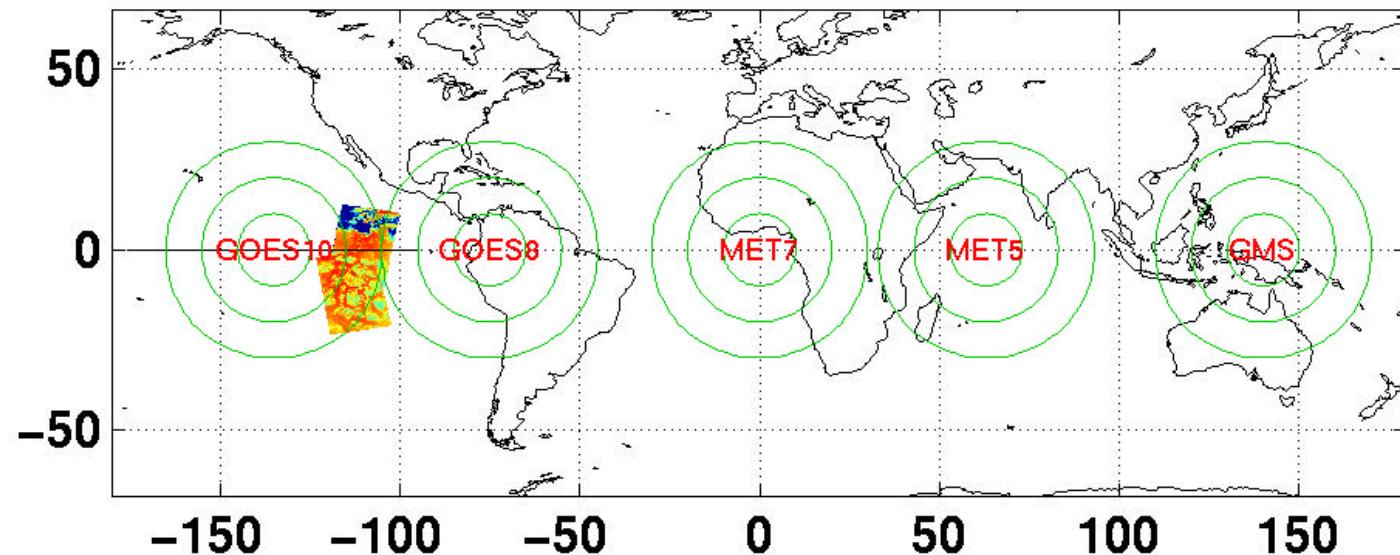


conv1 = *continuous* kcarta monochromatic calculation based on ECMWF profile coincident w/  
granule 089 convolved w/ GOES10 SRFs

conv2 = *continuous* kcarta monochromatic calculation based on ECMWF profile coincident w/  
granule 089 convolved w/ AIRS SRFs and then with GOES10 SRFs

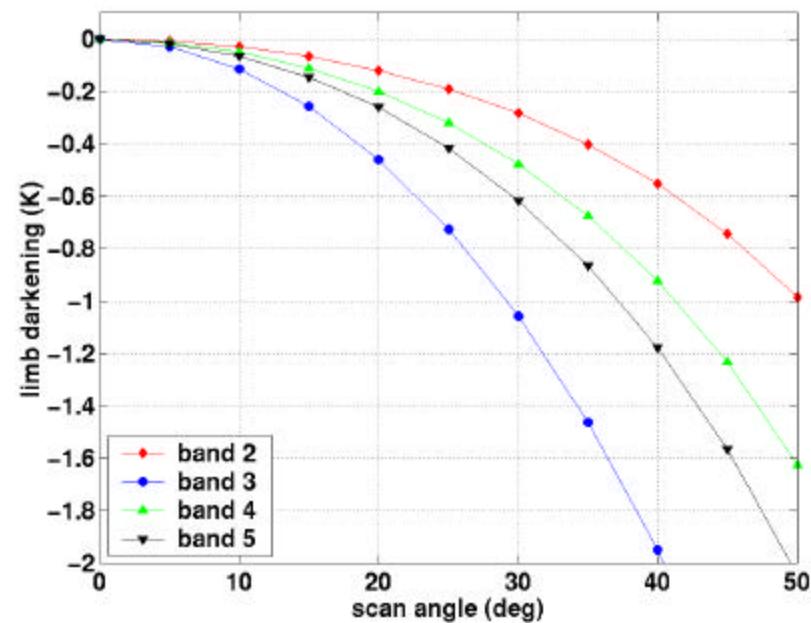
<u>Band</u>	<u>conv1(K)</u>	<u>conv2(K)</u>	<u>conv1-conv2(K)</u>
2	299.37	299.35	0.02
3	240.62	241.59	-0.97
4	294.29	294.27	0.02
5	291.10	291.06	-0.01

# GOES Limb darkening

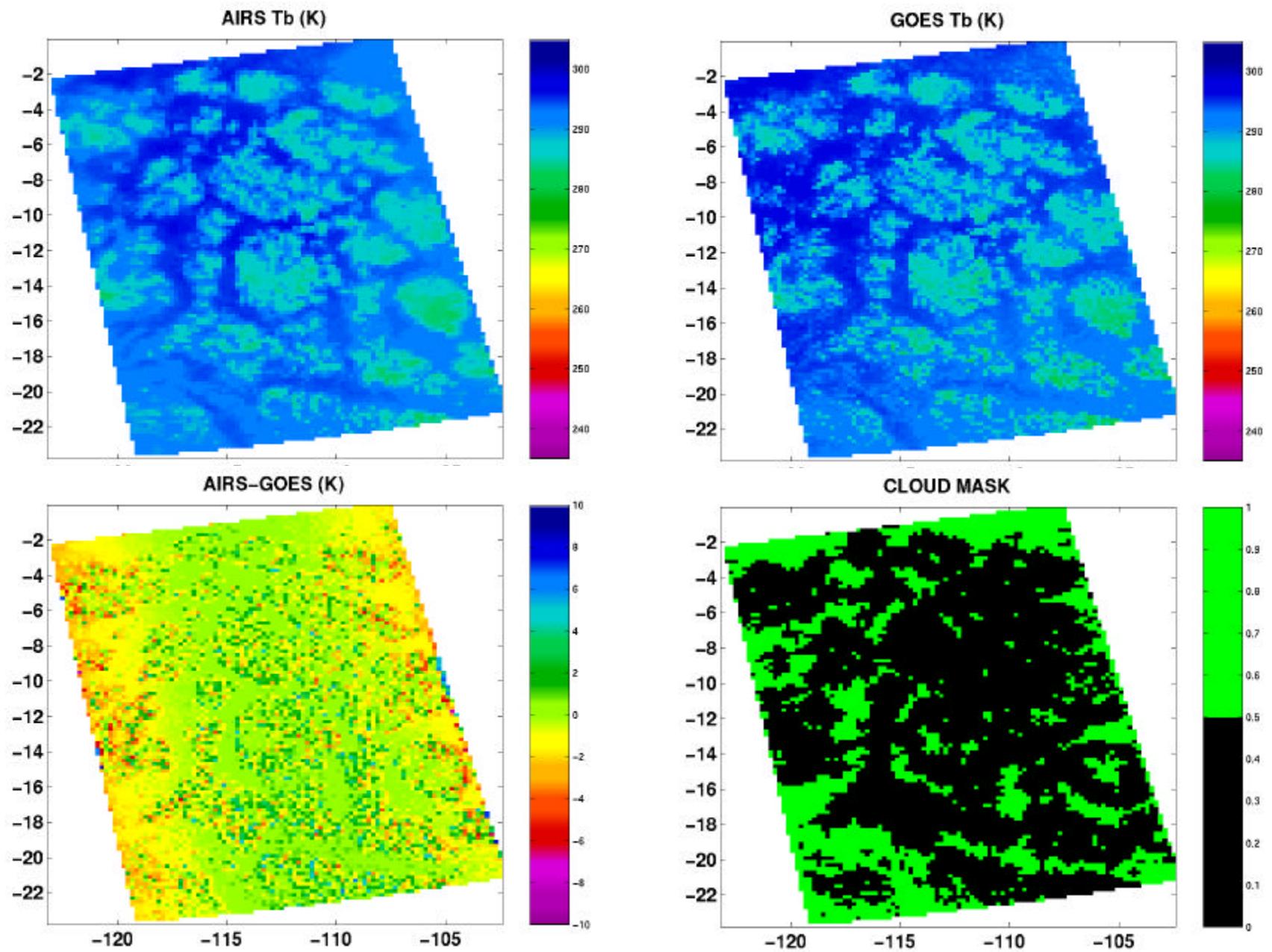


**Limb darkening:**  
standard Tropical atmosphere

Band	<u>Darkening at 25 deg</u>
2	0.20 K
3	0.75 K
4	0.32 K
5	0.40 K

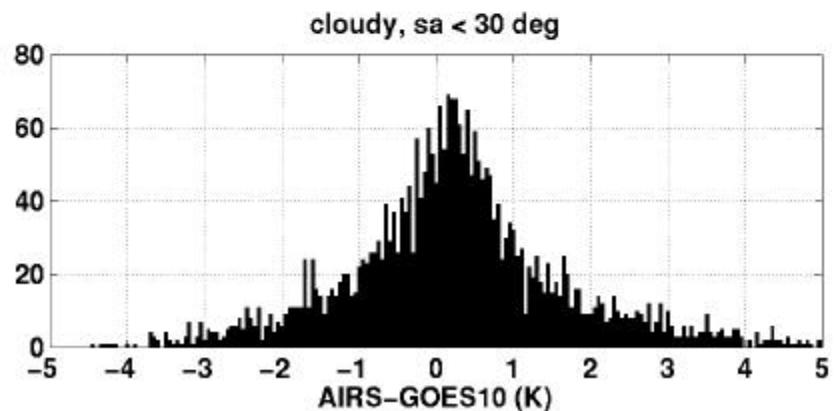
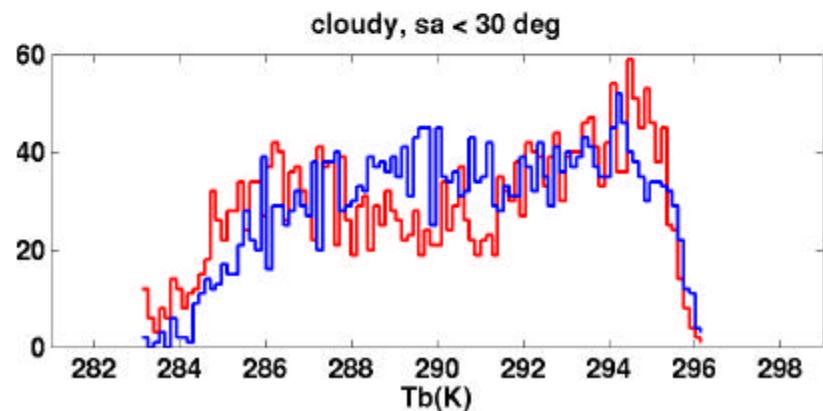
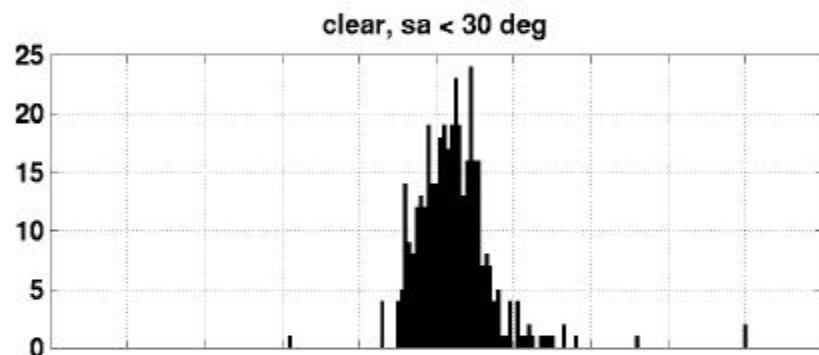
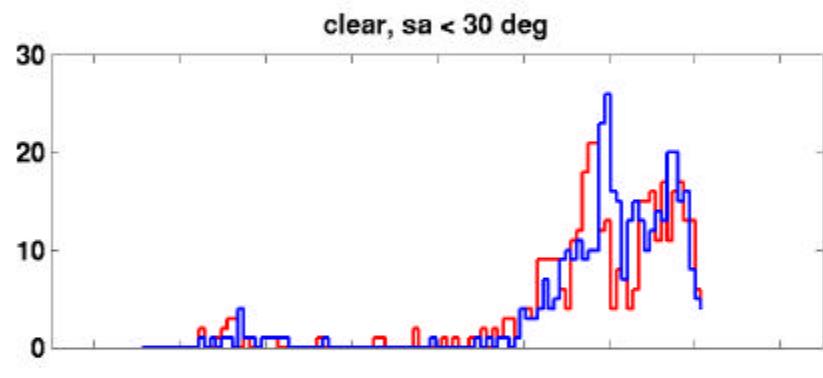
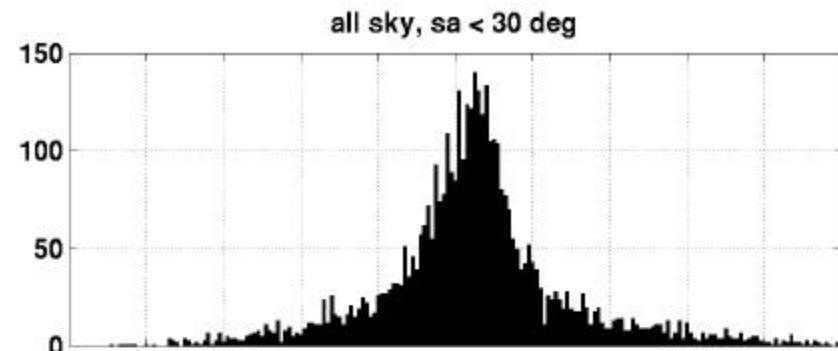
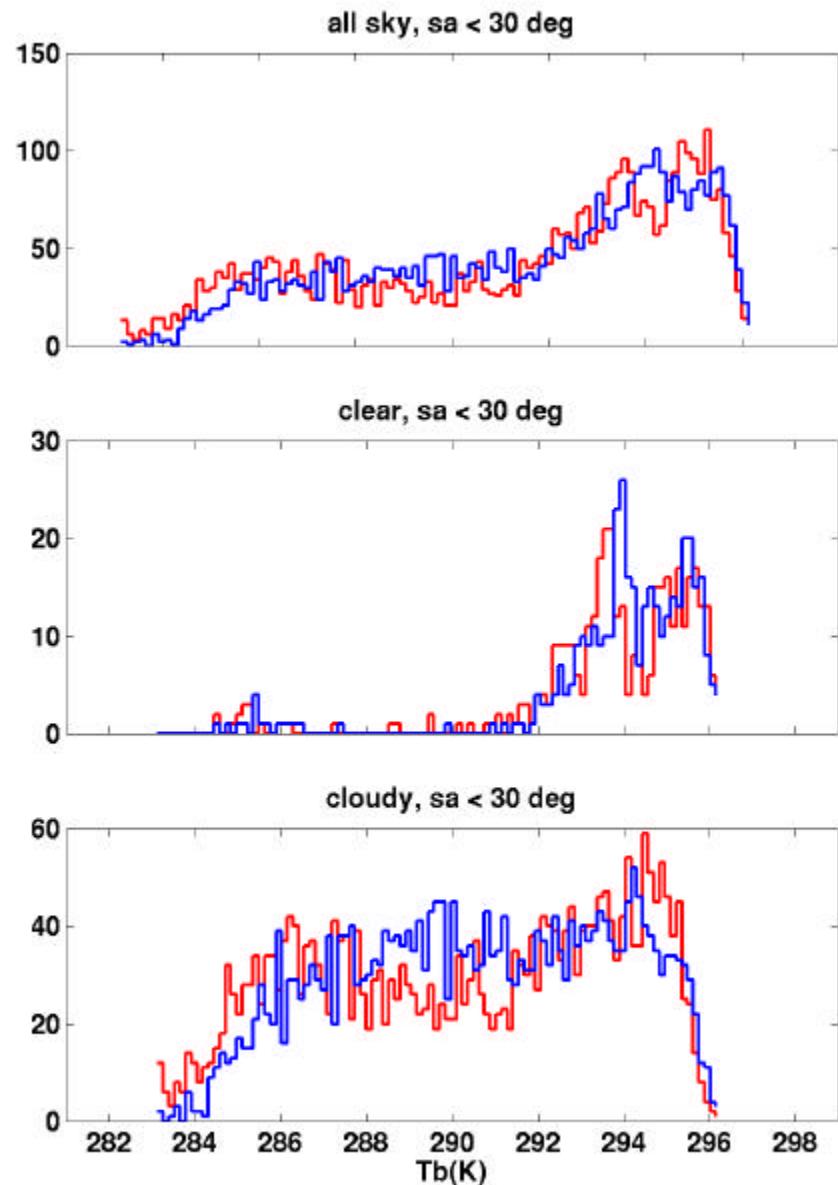


# Granule 212, Band 4 (~10.7μm)



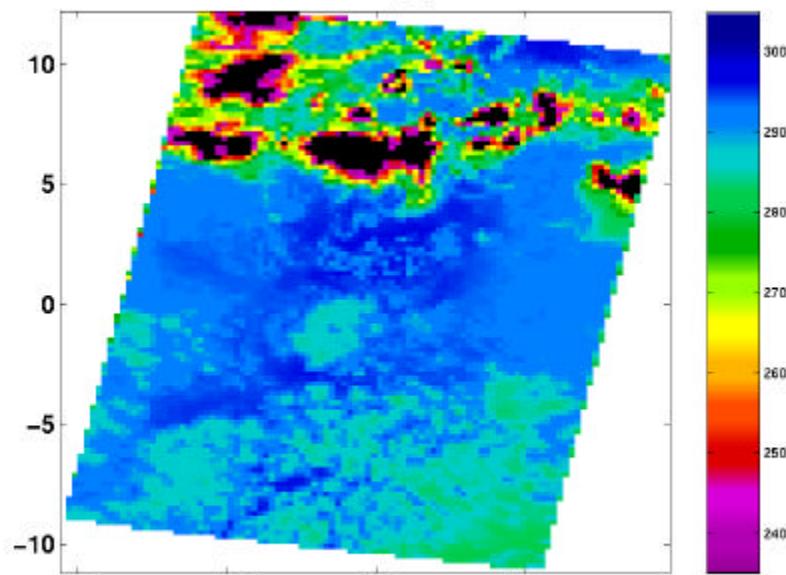


## Granule 212, Band 4 (~10.7μm)

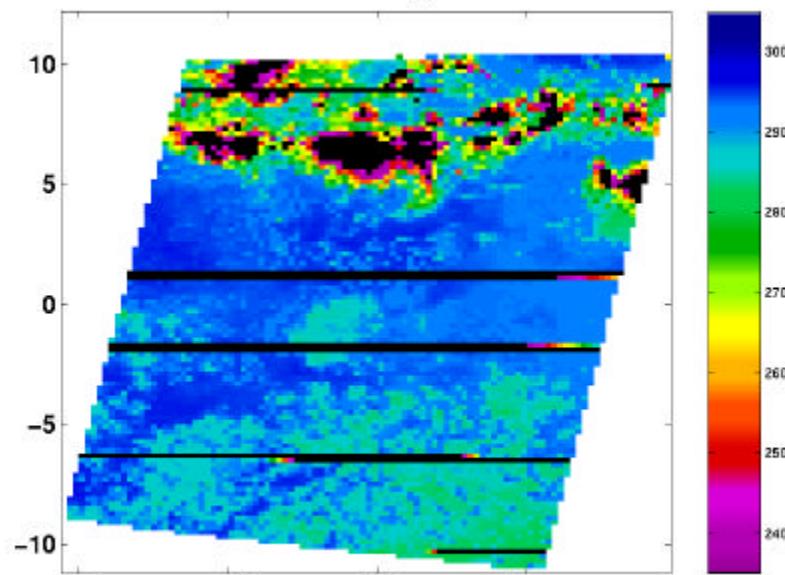


# Granule 089, Band 4 (~10.7μm)

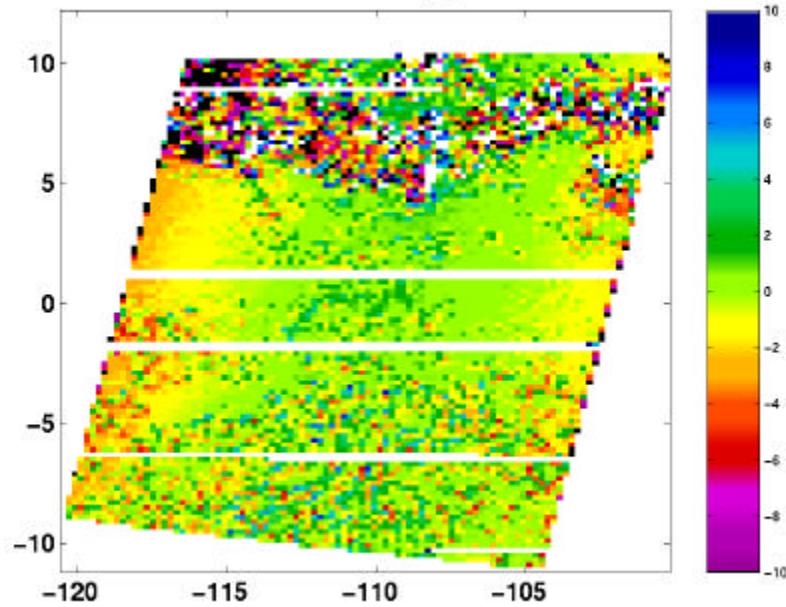
AIRS Tb (K)



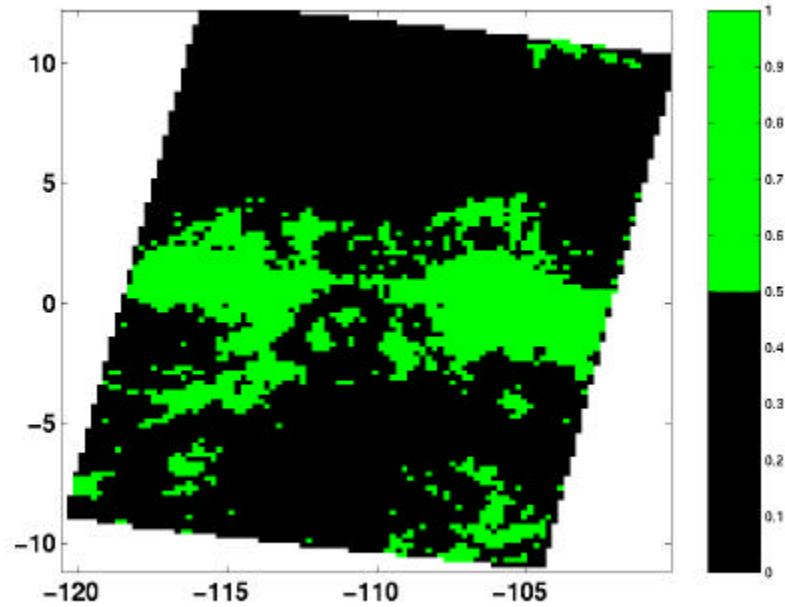
GOES Tb (K)



AIRS-GOES (K)

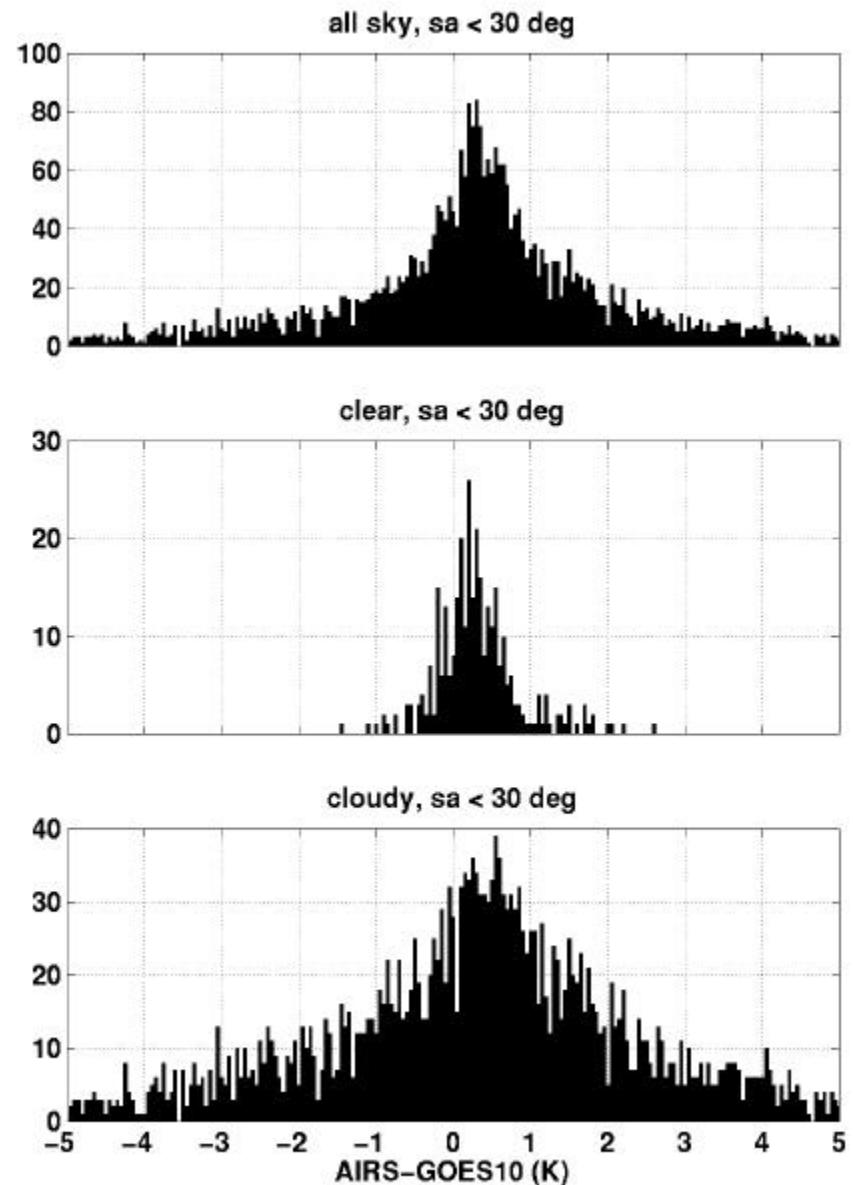
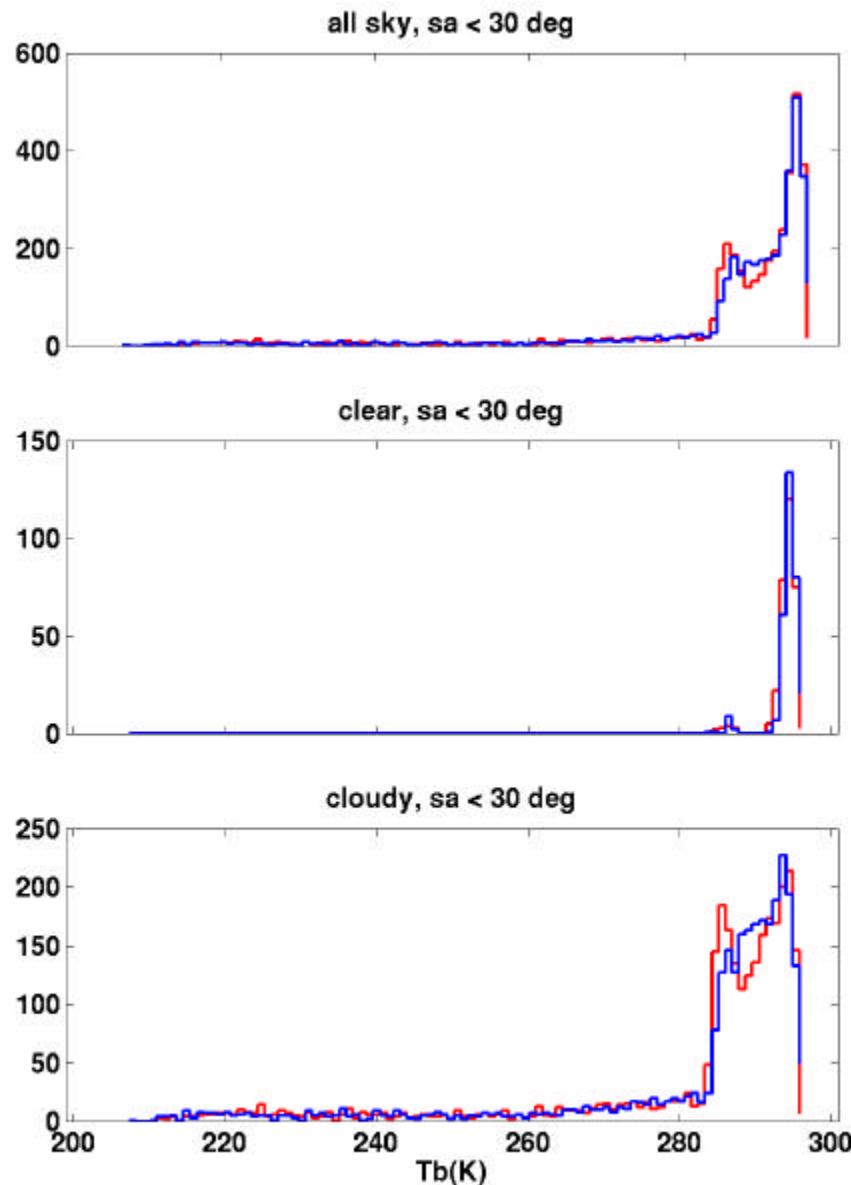


CLOUD MASK



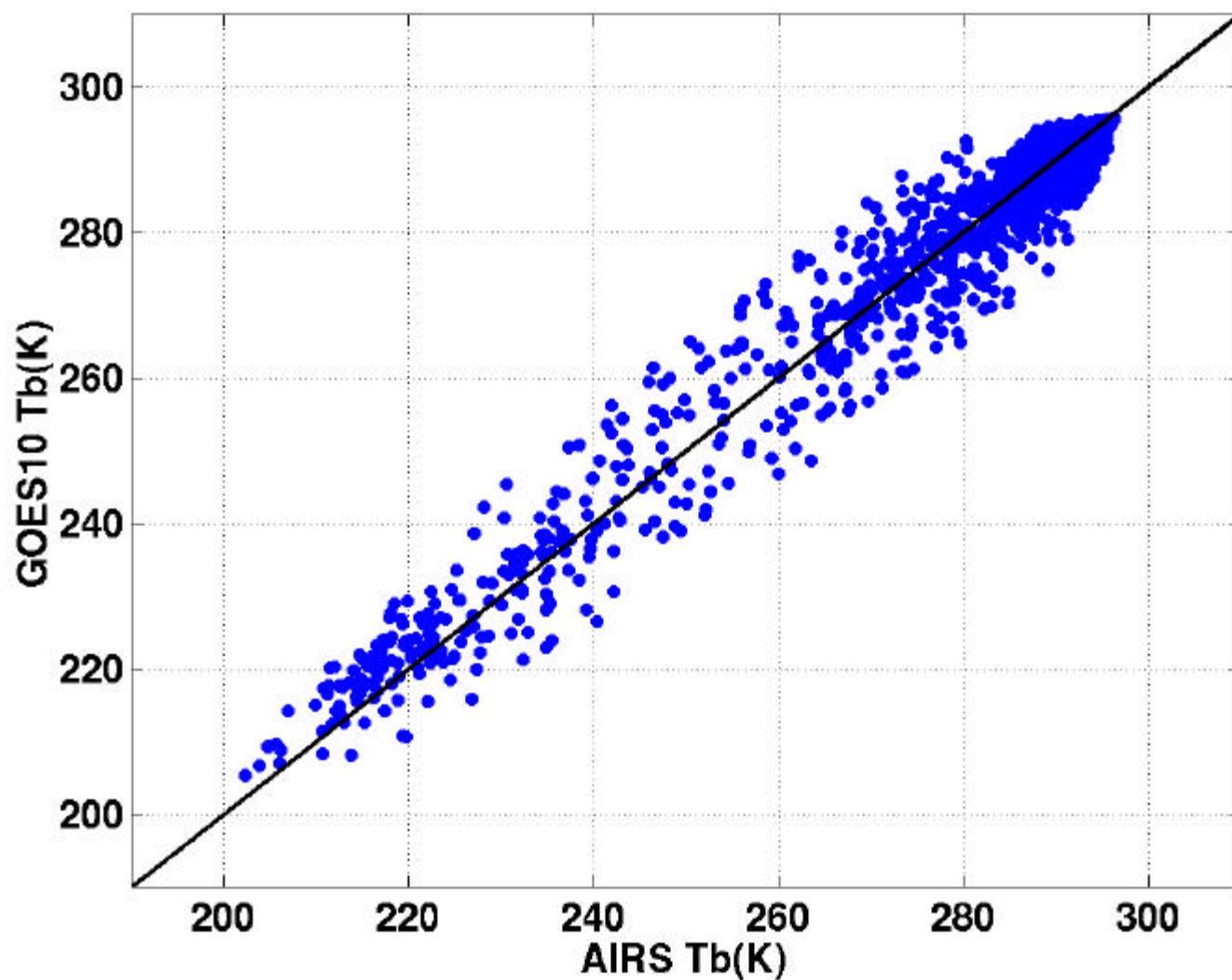


# Granule 089, Band 4 (~10.7 $\mu$ m)

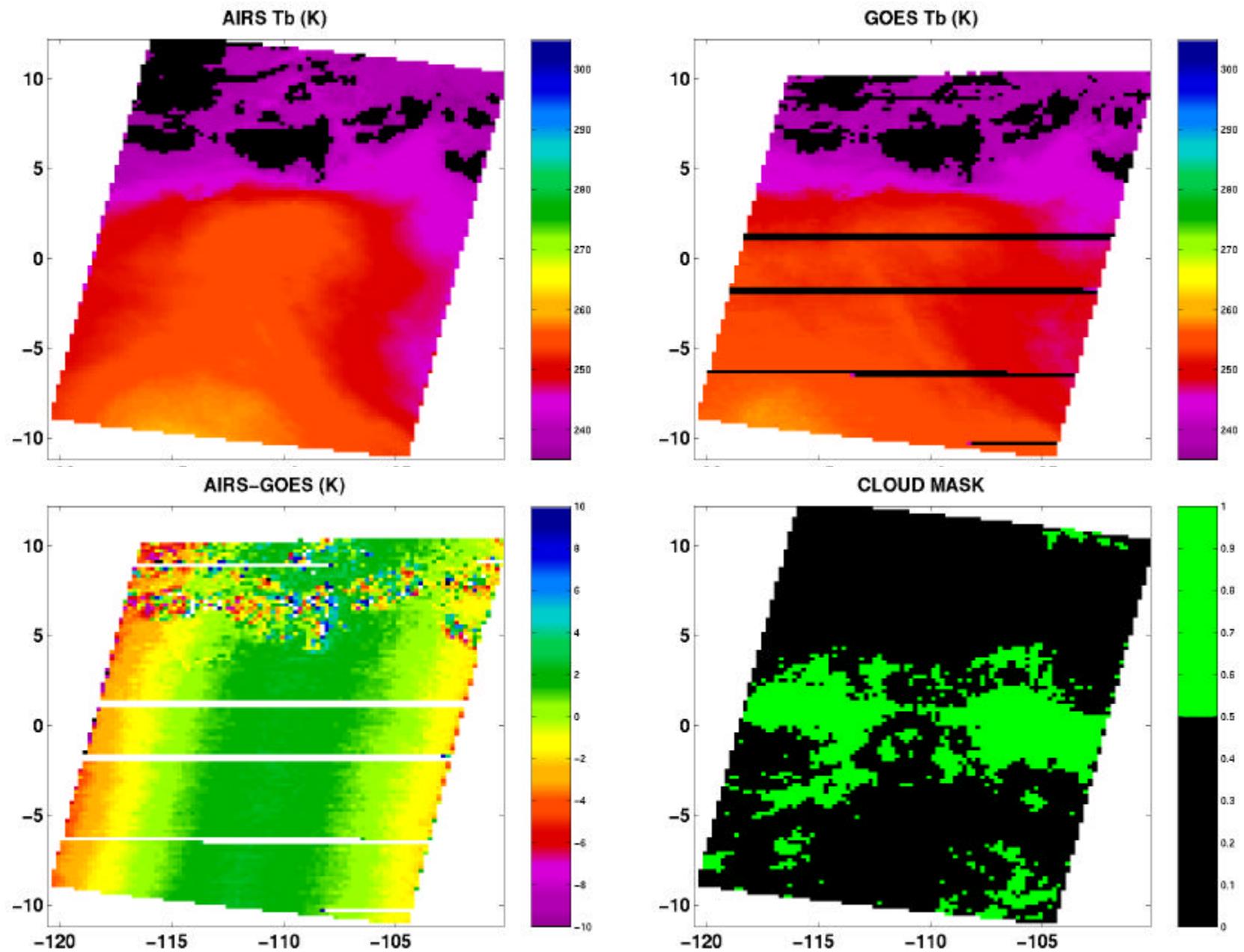


## Granule 089, Band 4 (~10.7 $\mu$ m)

all sky, sa < 30 deg

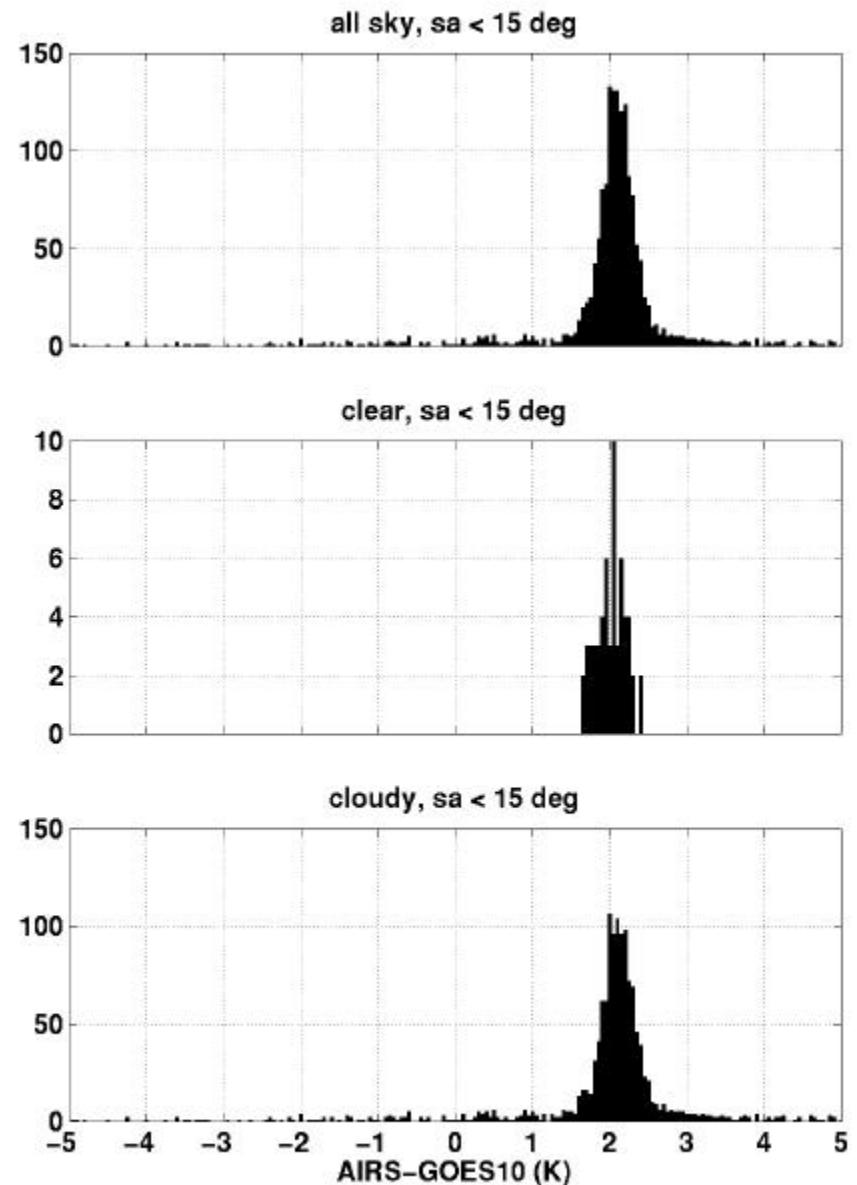
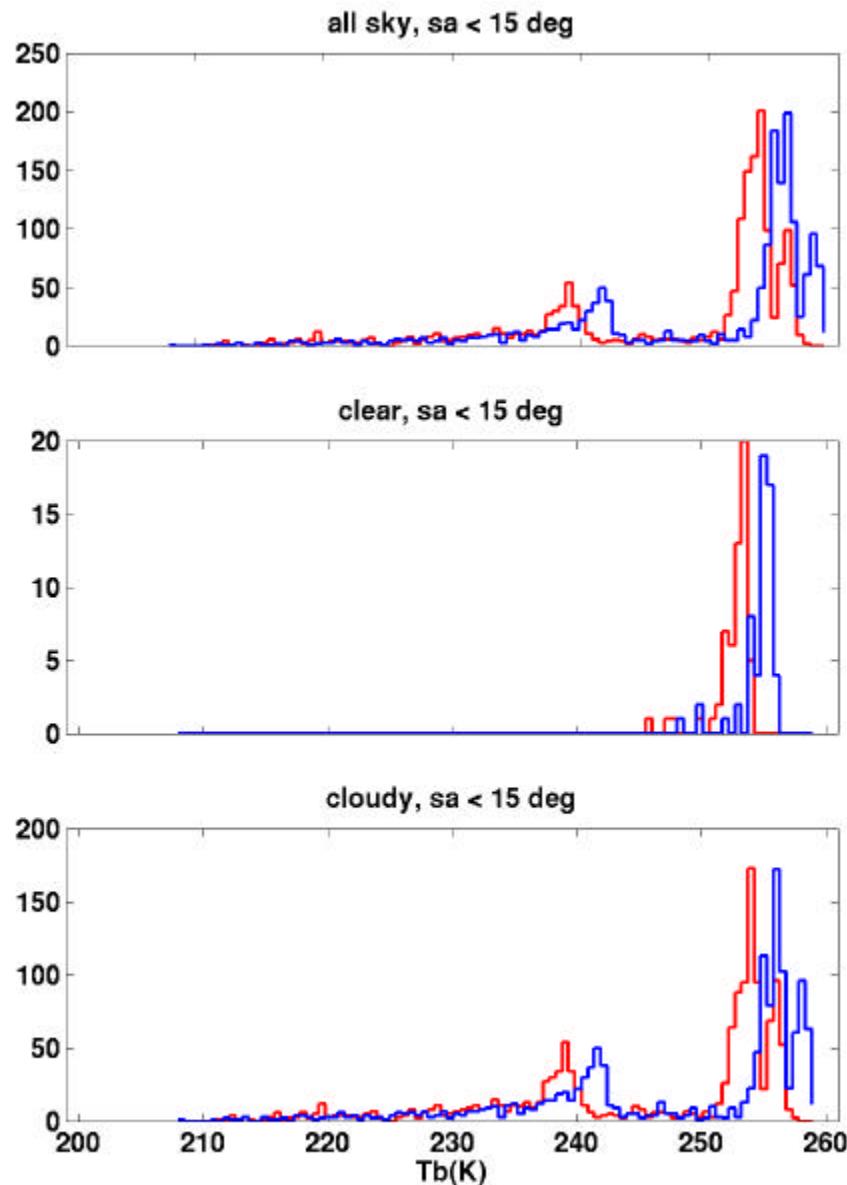


# Granule 089, Band 3 (~6.9 $\mu$ m)



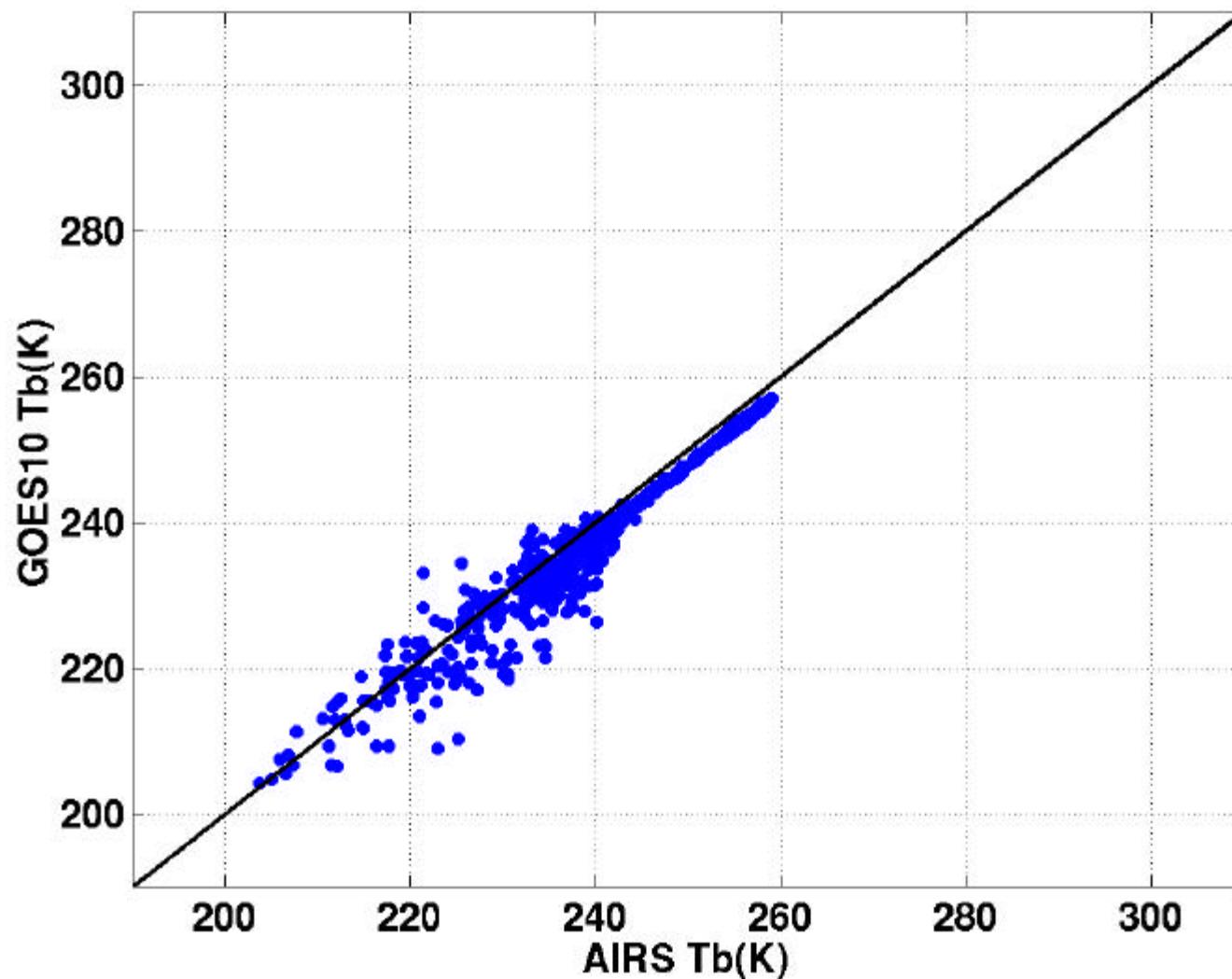
— AIRS  
— GOES-10

## Granule 212, Band 3 (~6.9 $\mu$ m)



# Granule 212, Band 3 (~6.9 $\mu$ m)

all sky, sa < 15 deg



# Broadband radiance evaluation using Geo's

- Summary:

**mean brightness temperature differences, clear sky only:**

<u>Granule</u>	<u>Band</u>	<u>AIRS</u>	<u>GOES</u>	<u>(AIRS-GOES)</u>	<u>ConvError</u>	<u>GOESLD</u>	<u>AIRS LD</u>	<u>(AIRS-GOES)'</u>
089	2 (3.9um)	295.108	295.114	-0.005	0.02	0.20	0.14	<b>-0.05</b>
212	2 (3.9um)	295.847	296.093	-0.245	0.02	0.20	0.14	<b>0.56</b>
089	3 (6.7um)	254.379	252.367	2.012	-0.97	0.75	0.15	<b>0.44</b>
212	3 (6.7um)	257.619	255.298	2.321	-0.97	0.75	0.15	<b>0.75</b>
089	4 (10.7um)	293.901	293.595	0.306	0.02	0.32	0.23	<b>0.24</b>
212	4 (10.7um)	293.907	293.681	0.226	0.02	0.32	0.23	<b>0.16</b>
089	5 (12.0um)	291.579	291.631	-0.051	-0.01	0.40	0.30	<b>-0.16</b>
212	5 (12.0um)	292.053	292.020	0.033	-0.01	0.40	0.30	<b>-0.08</b>

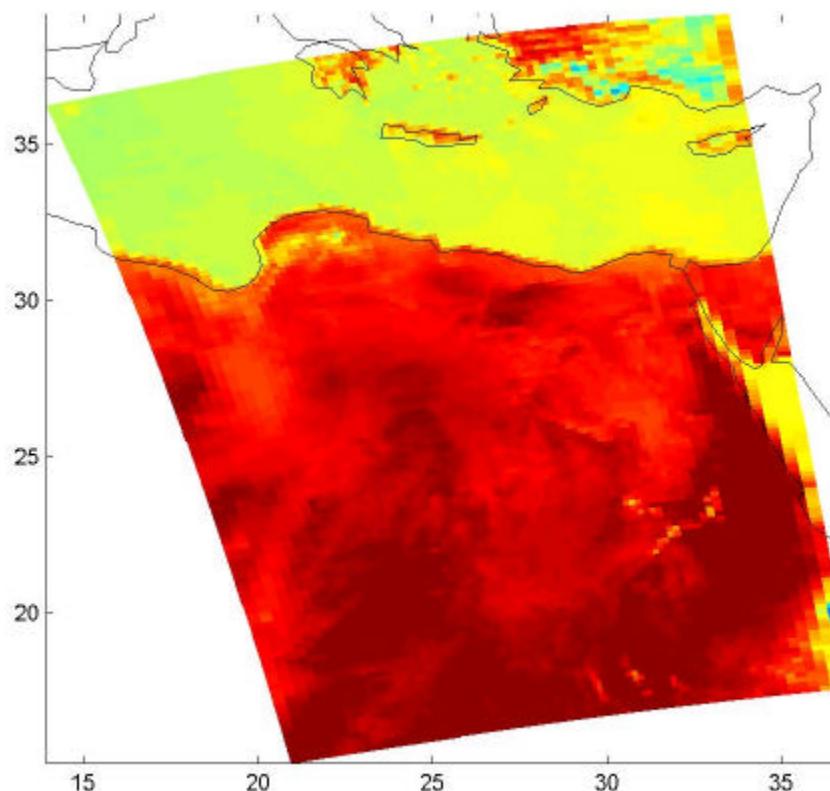
- Initial clear sky comparisons look good !
- and, cold-end comparisons using clouds in granule 089 reveal no major problems
- For the 06/14 focus day, granules 229 and 105/106 would provide better comparisons (negligible limb darkening) for GOES-10 comparisons

# Surface Emissivity Survey

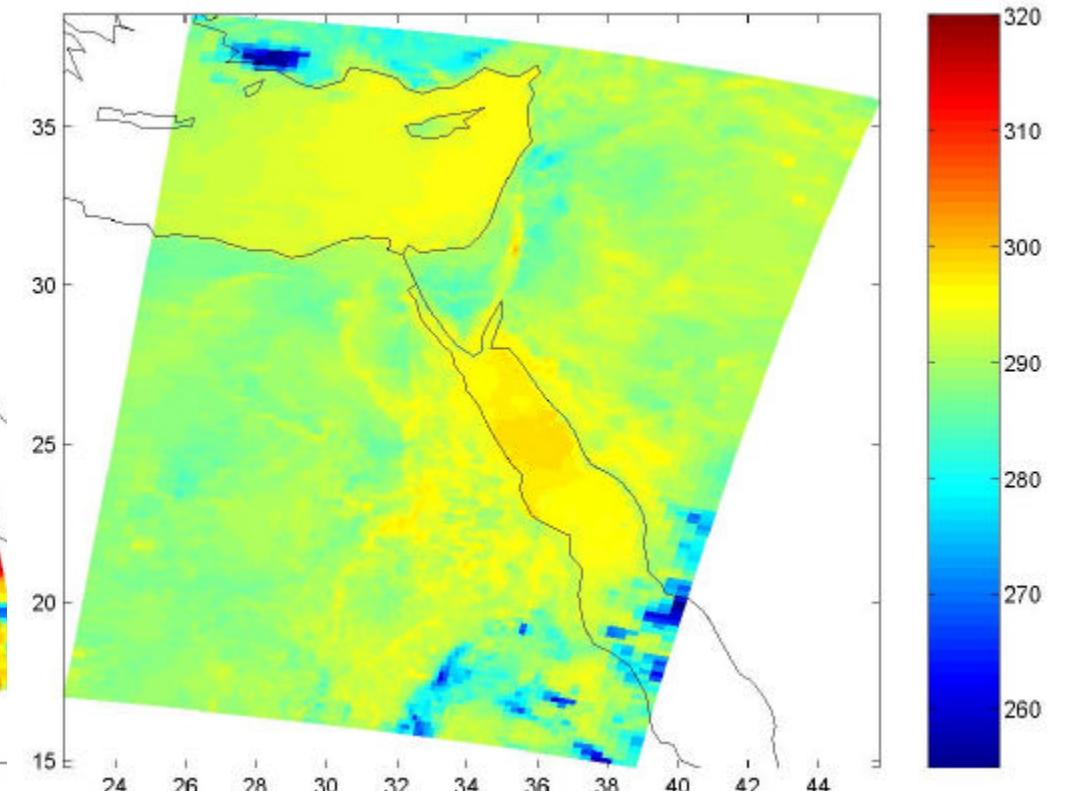
Granules 105, 115, 236; 14 June 2002

## Day-Night Thermal Contrast

Day (115)



Night (236)

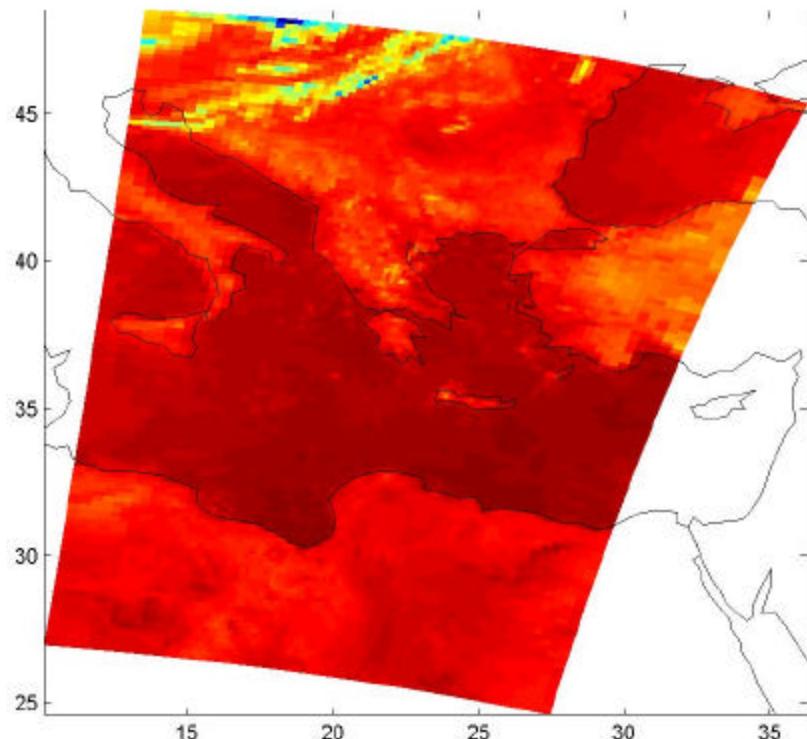


981 cm<sup>-1</sup> Brightness Temperature

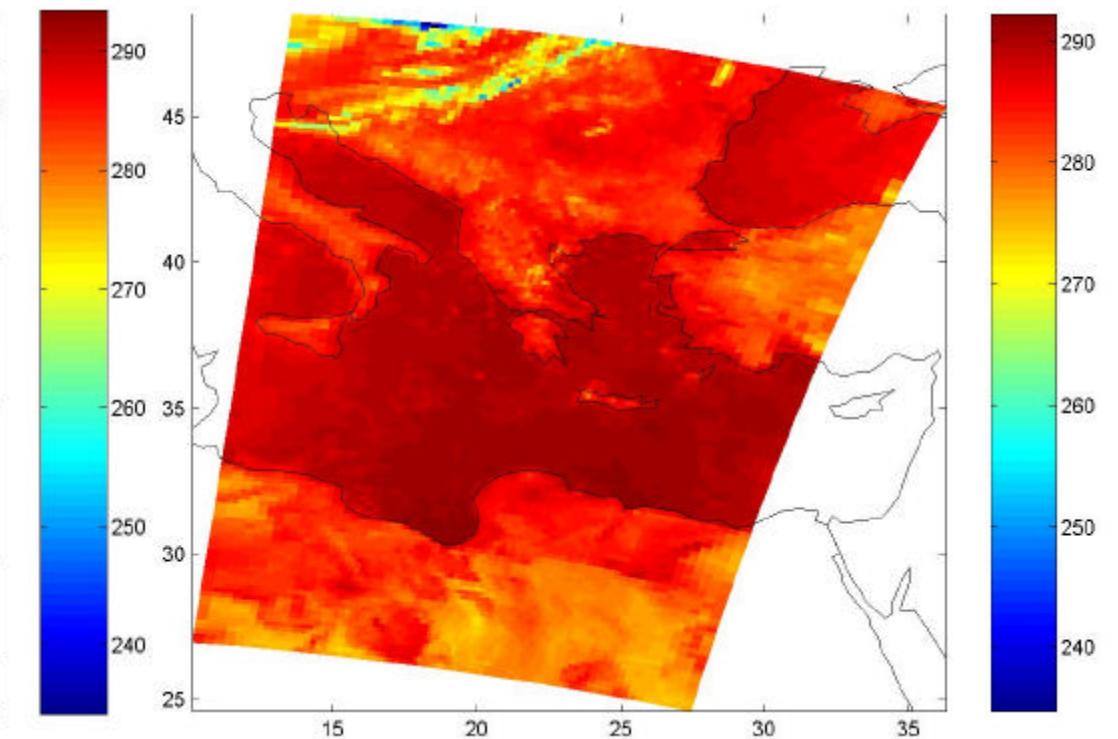
# 981 & 1086 cm<sup>-1</sup> Brightness Temperatures

## Granules 005, Night, 14 June 2002

981 cm<sup>-1</sup>



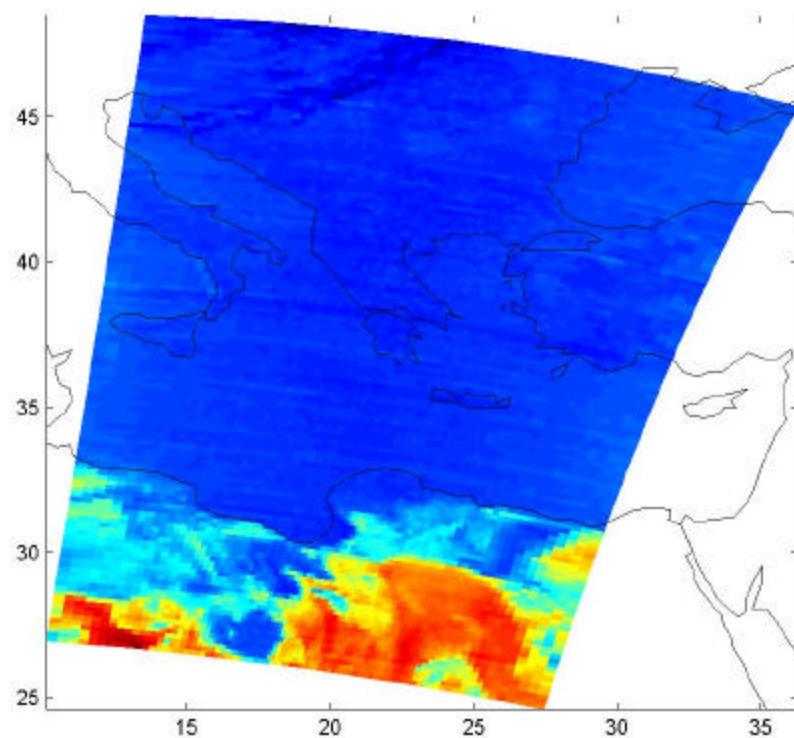
1086 cm<sup>-1</sup>



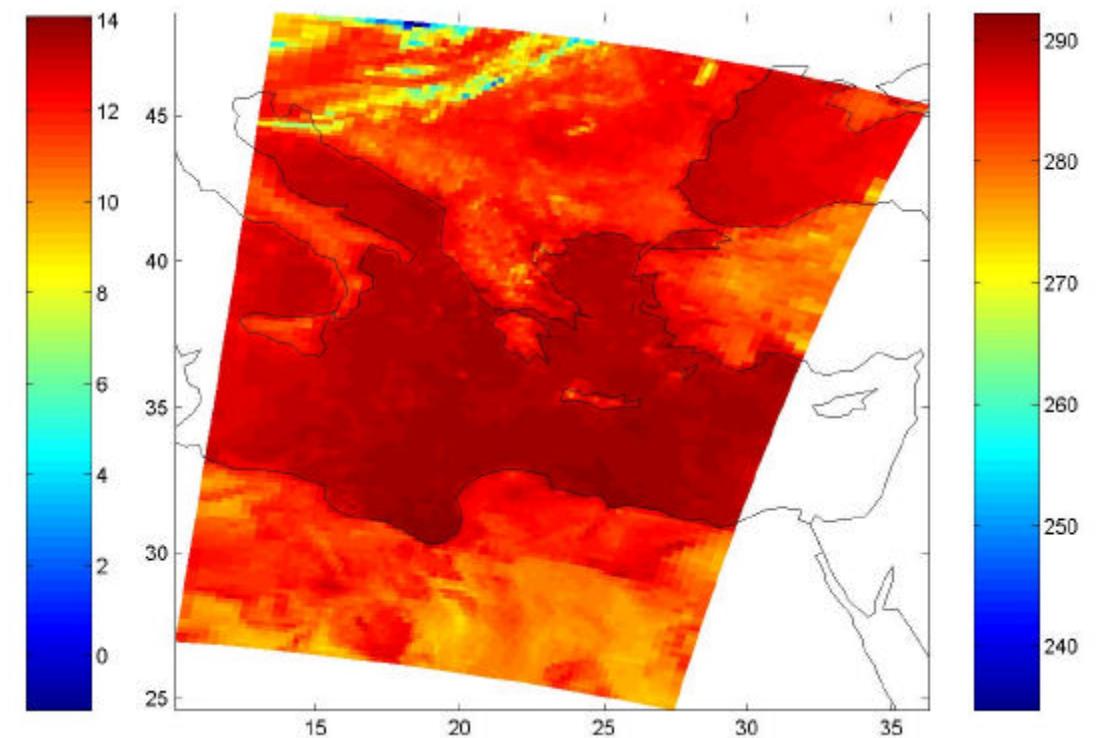
# 981-1086 cm<sup>-1</sup> as Barren Region Detector

## Granules 005, Night, 14 June 2002

$T(981)-T(1086)$

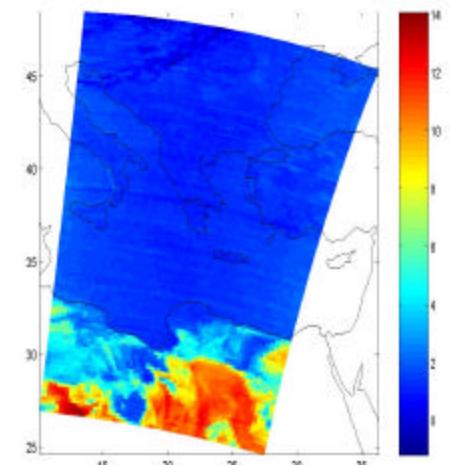


1086 cm<sup>-1</sup>

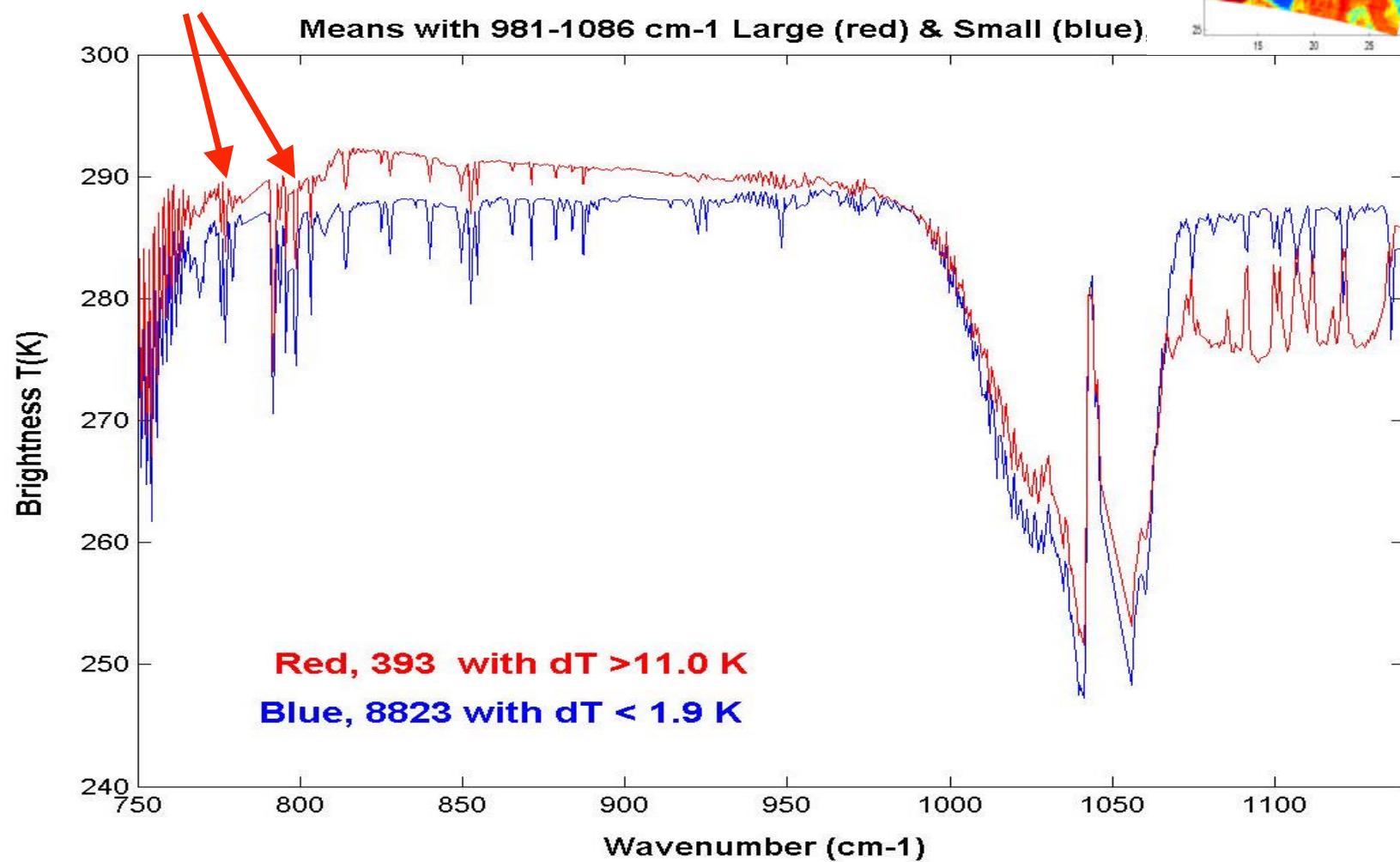


# Barren vs Water/Vegetated Surface

Granule 005, Night, 14 June 2002



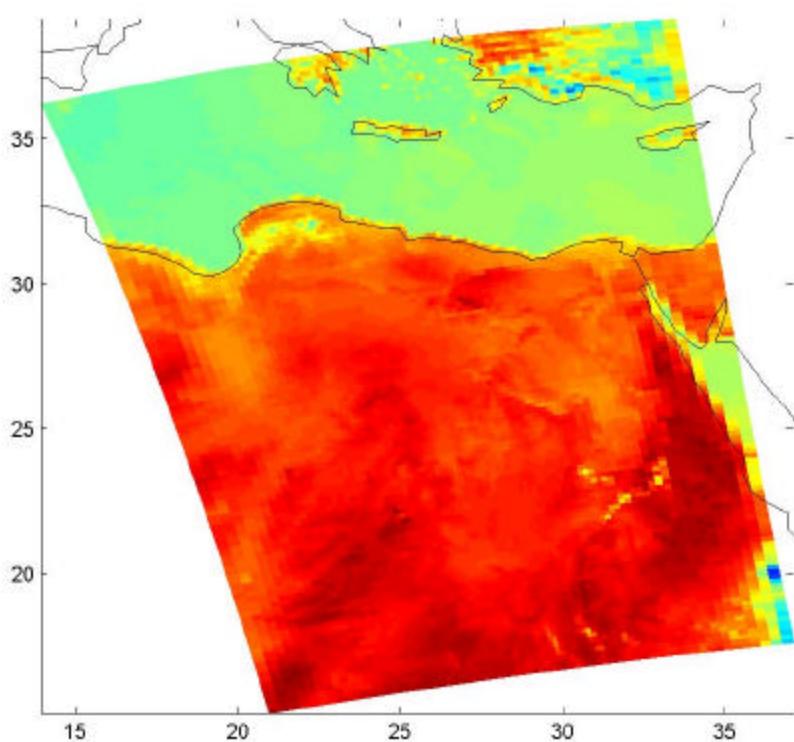
Restrahlen Features



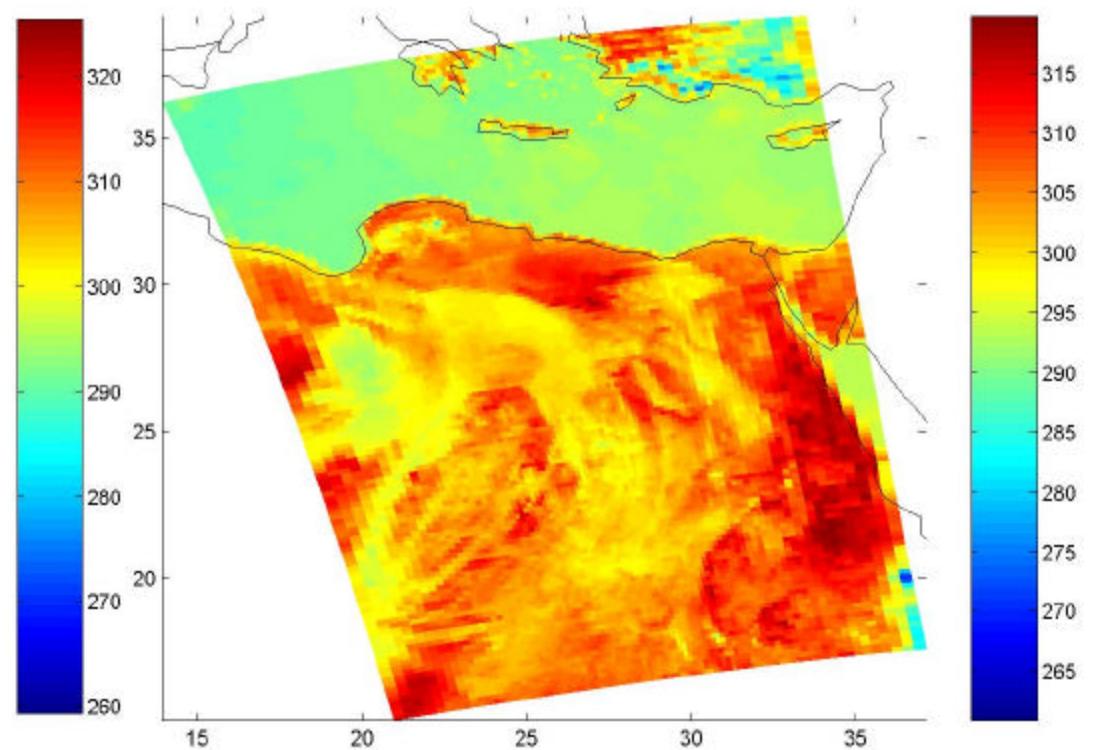
# 981 & 1086 cm<sup>-1</sup> Brightness Temperatures

## Granules 115, Day, 14 June 2002

981 cm<sup>-1</sup>



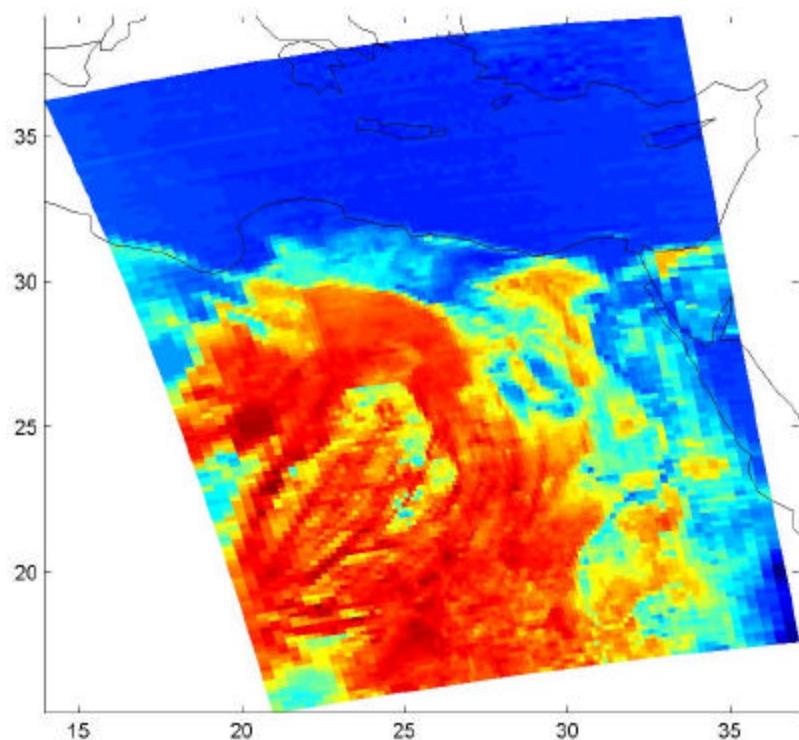
1086 cm<sup>-1</sup>



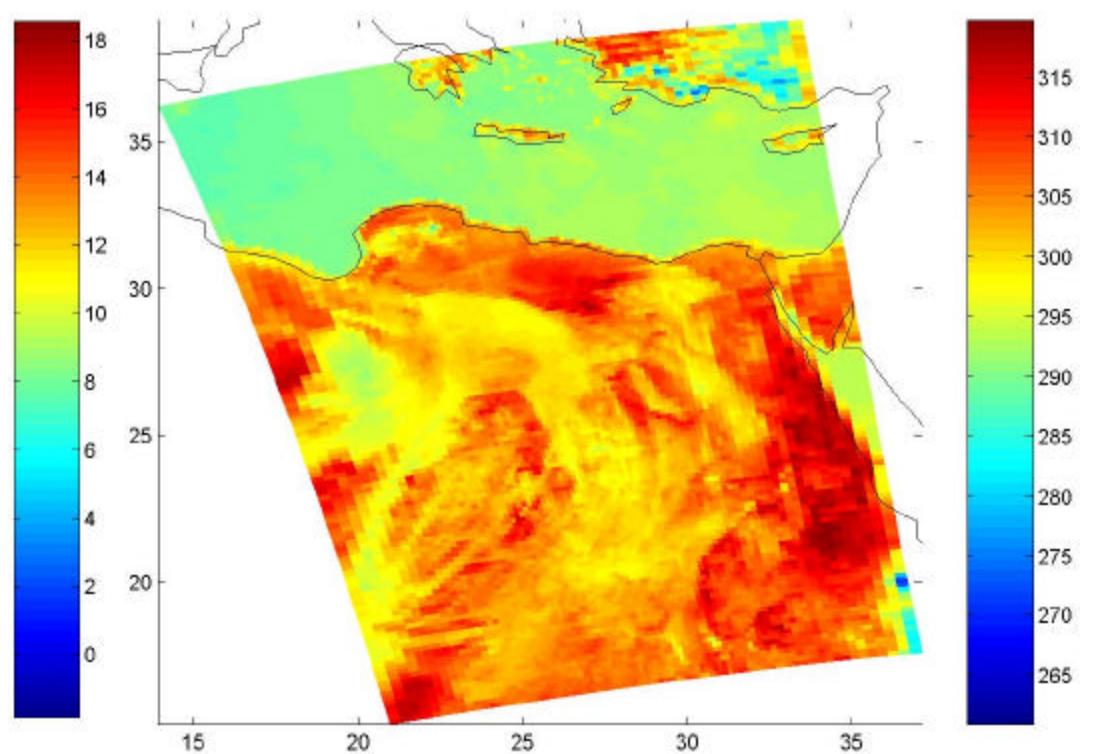
# **981-1086 cm<sup>-1</sup> as Barren Region Detector**

## **Granule 115, Day, 14 June 2002**

**T(981)-T(1086)**

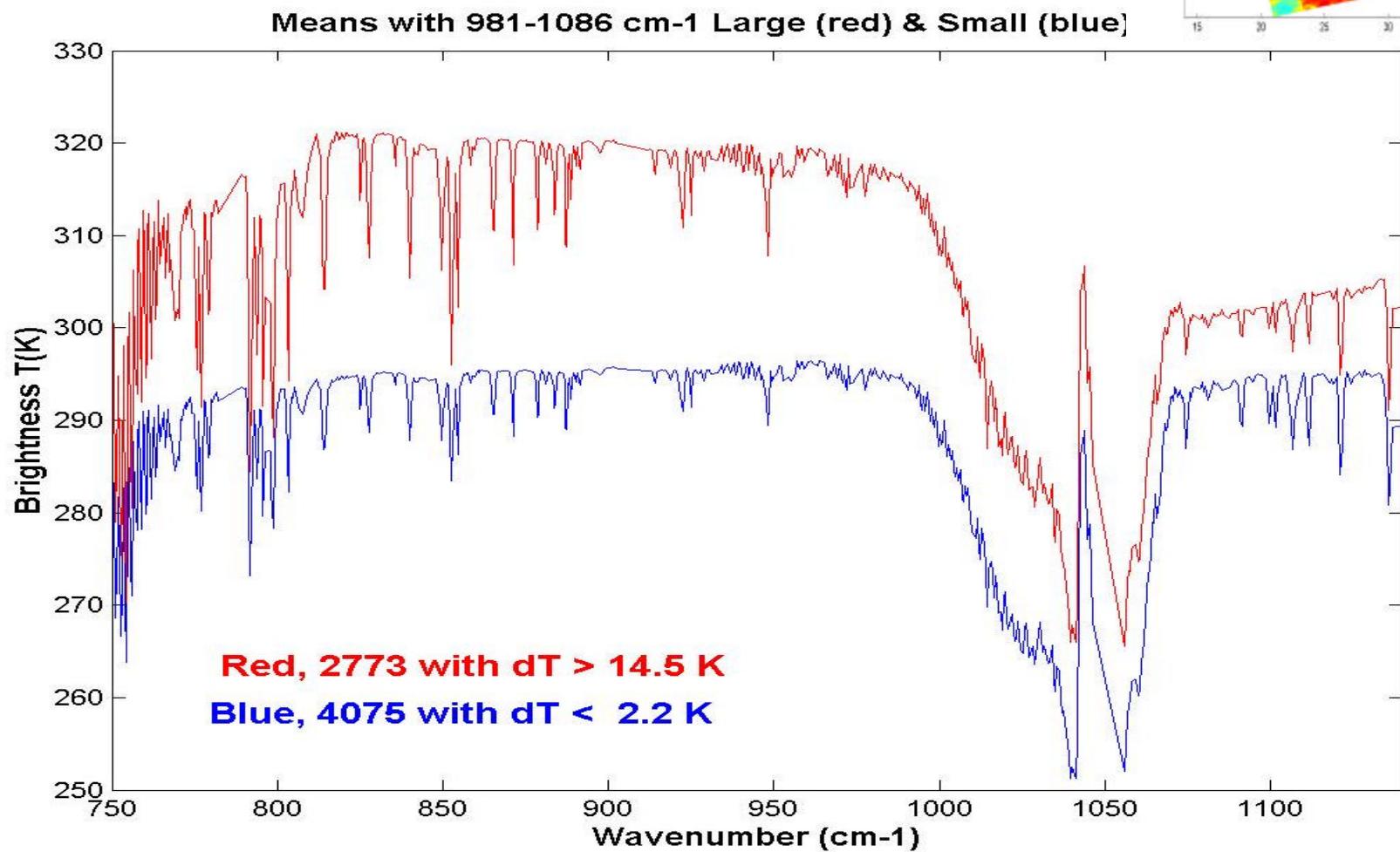
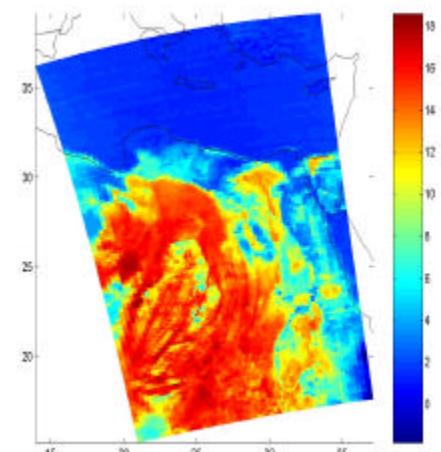


**T(1086 cm<sup>-1</sup>)**



# Barren vs Water/Vegetated Surface

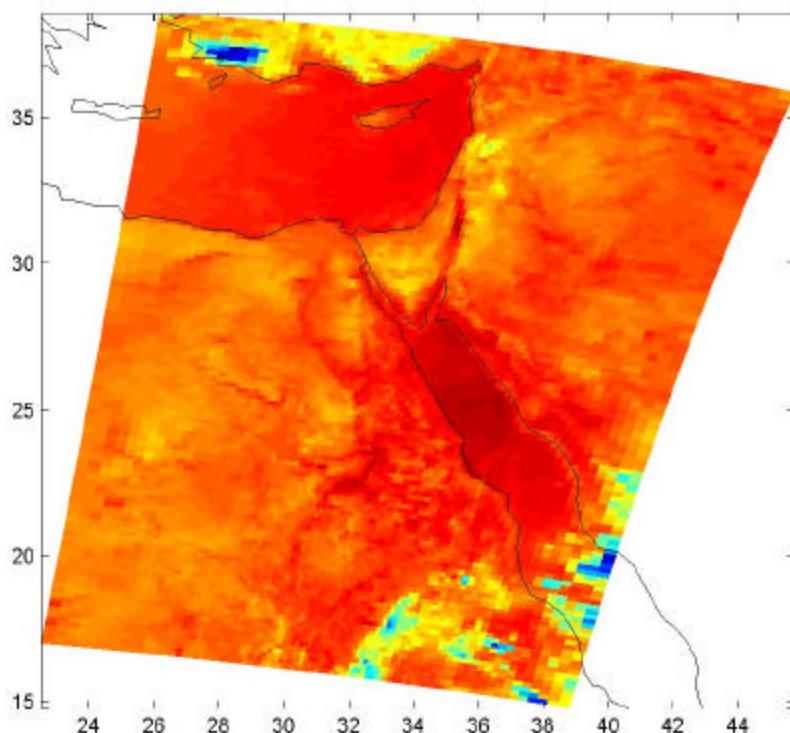
Granule 115, Day, 14 June 2002



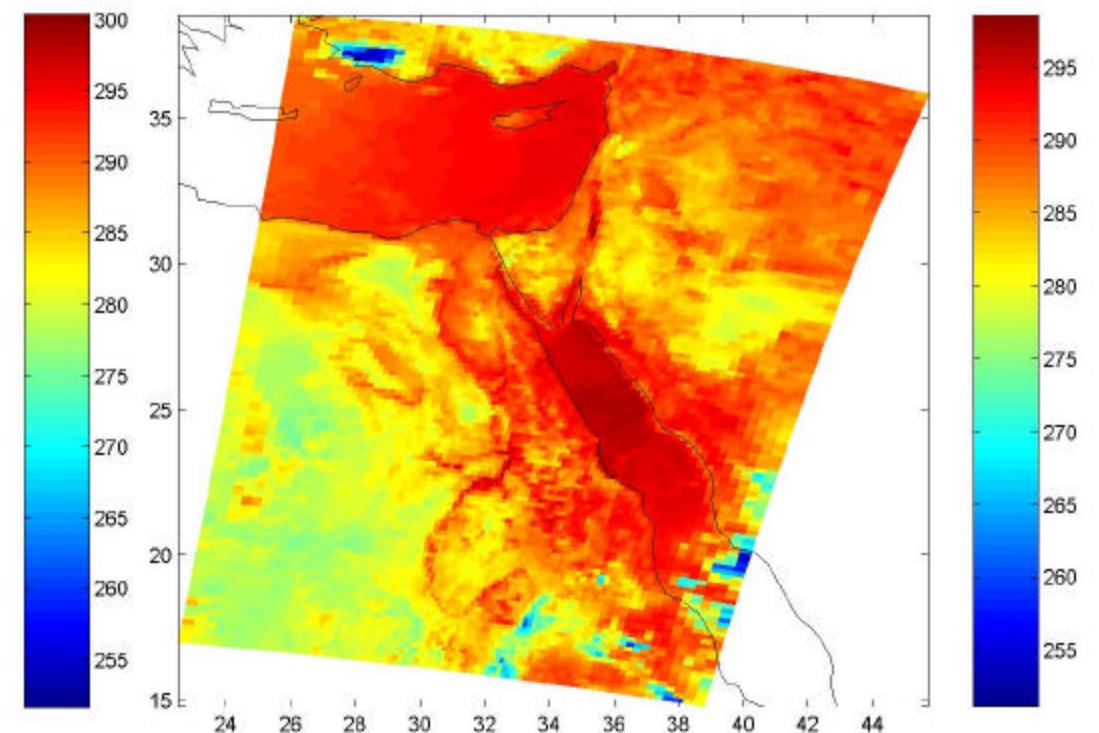
# 981 & 1086 cm<sup>-1</sup> Brightness Temperatures

## Granules 236, Night, 14 June 2002

981 cm<sup>-1</sup>



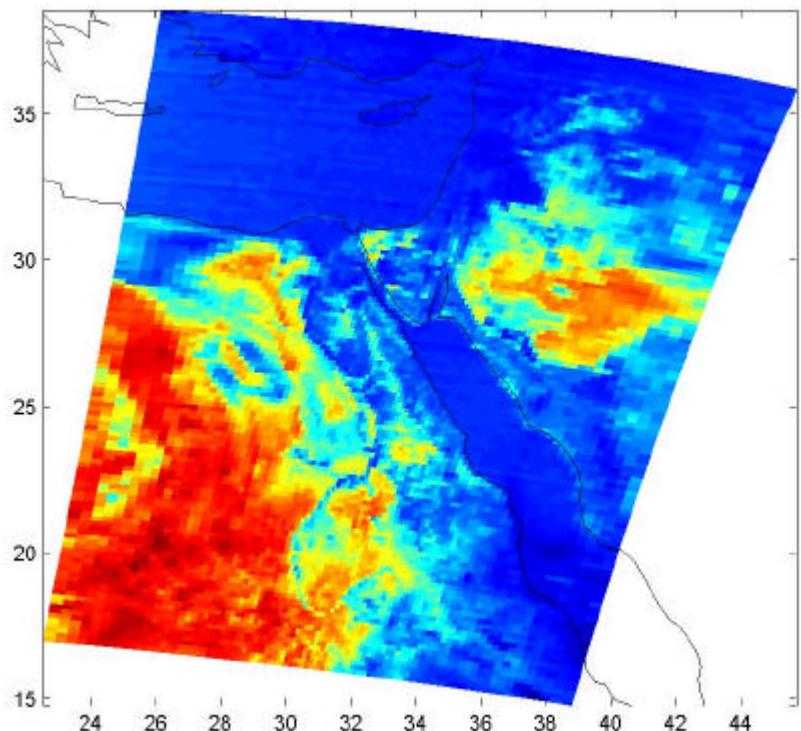
1086 cm<sup>-1</sup>



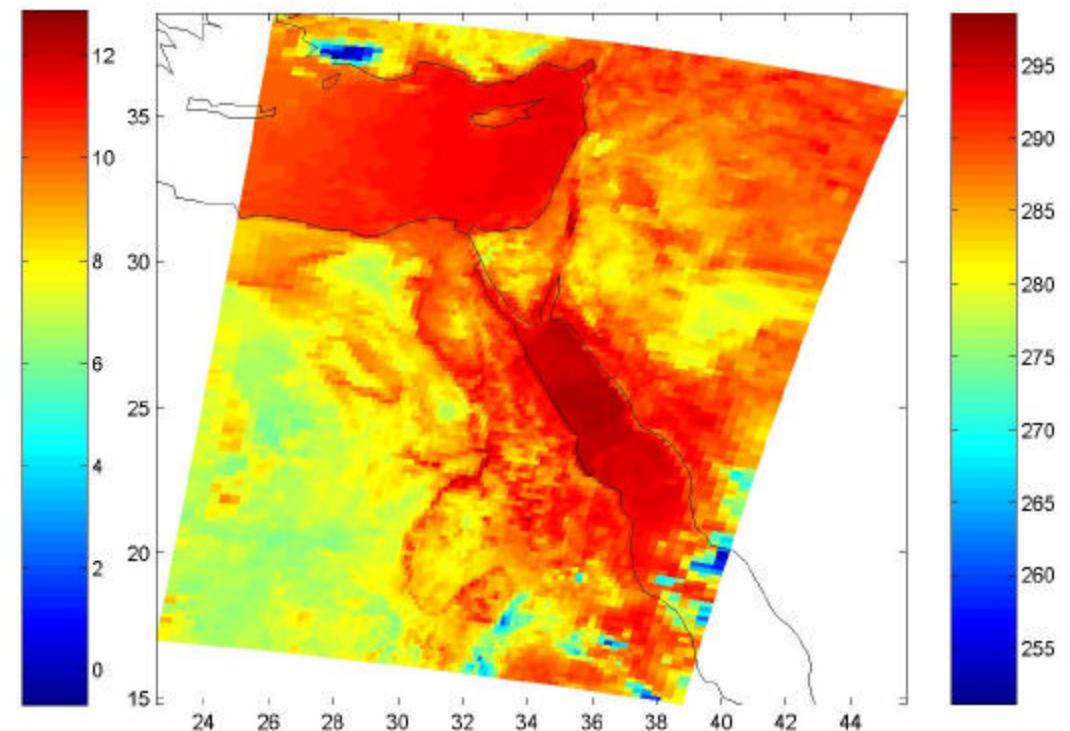
# 981-1086 cm<sup>-1</sup> as Barren Region Detector

## Granule 236, Night, 14 June 2002

T(981)-T(1086)

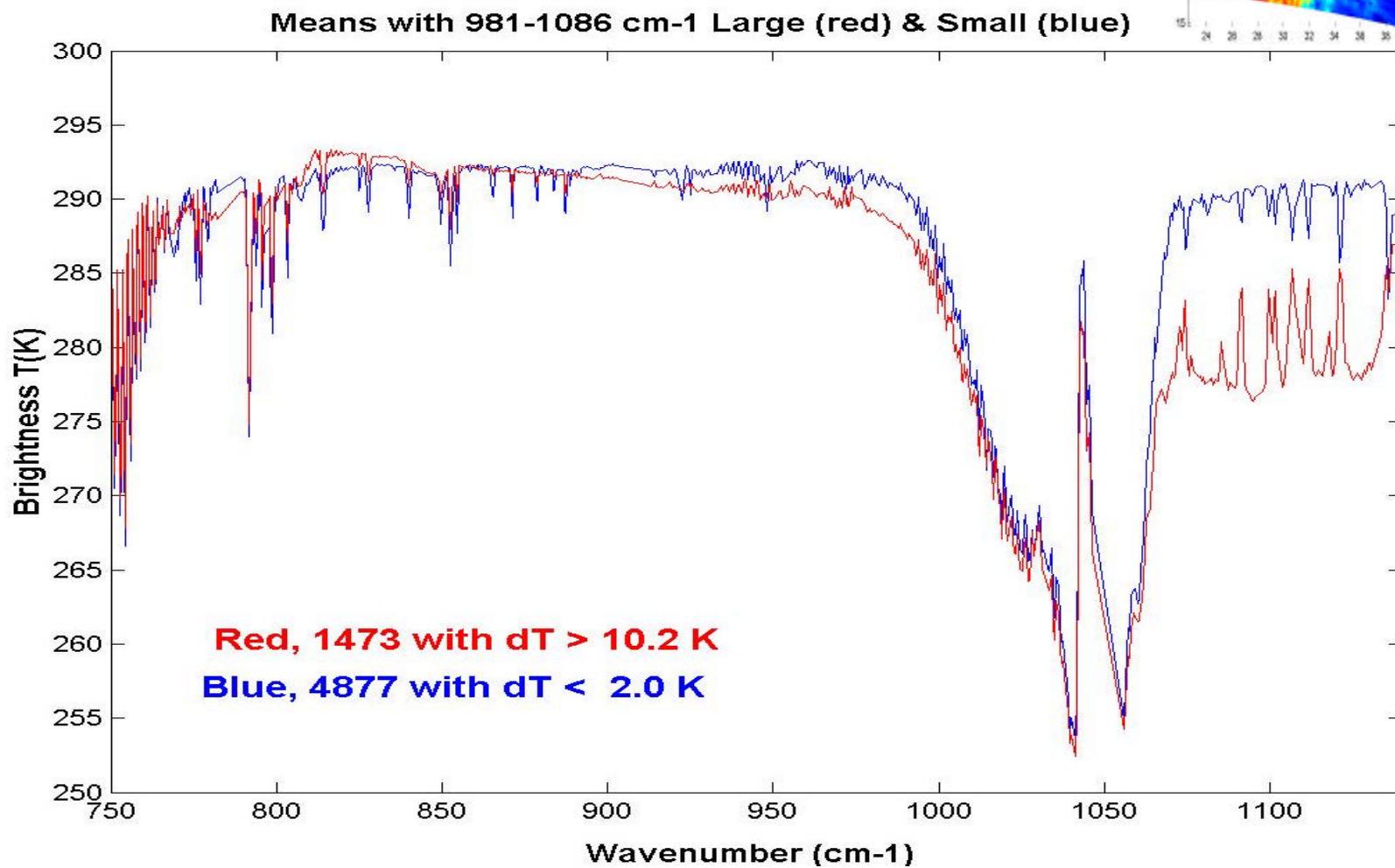
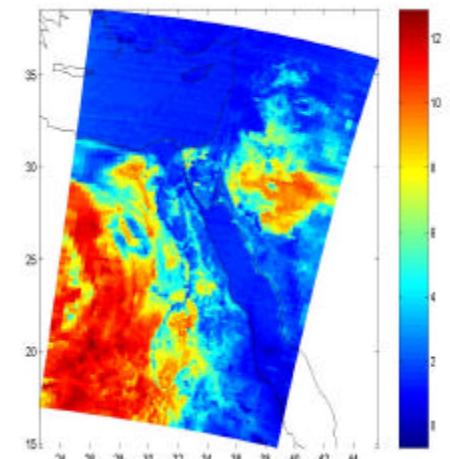


T(1086 cm<sup>-1</sup>)



# Barren vs Water/Vegetated Surface

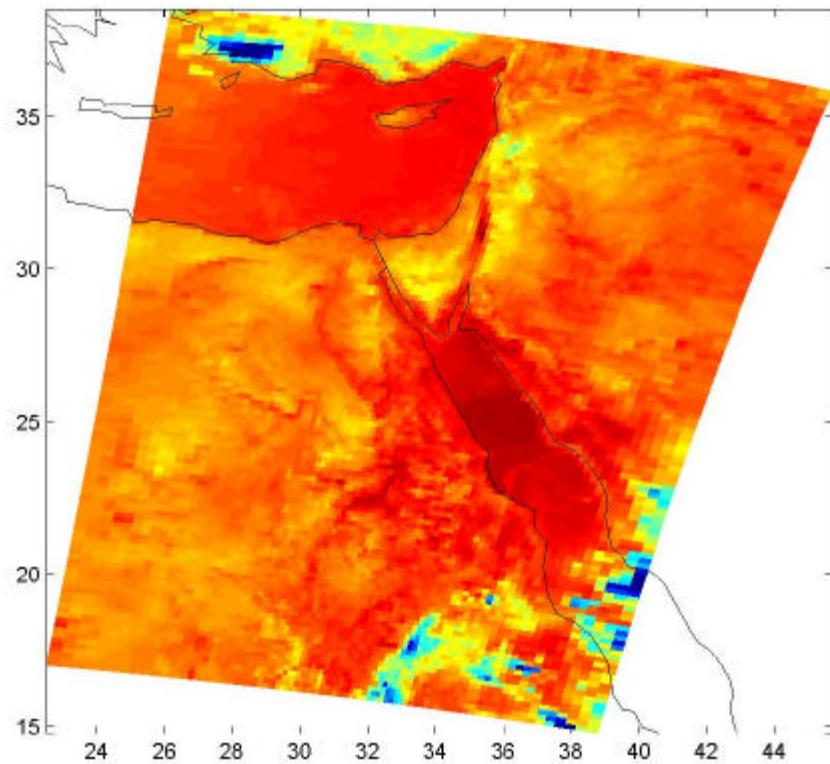
Granule 236, Night, 14 June 2002



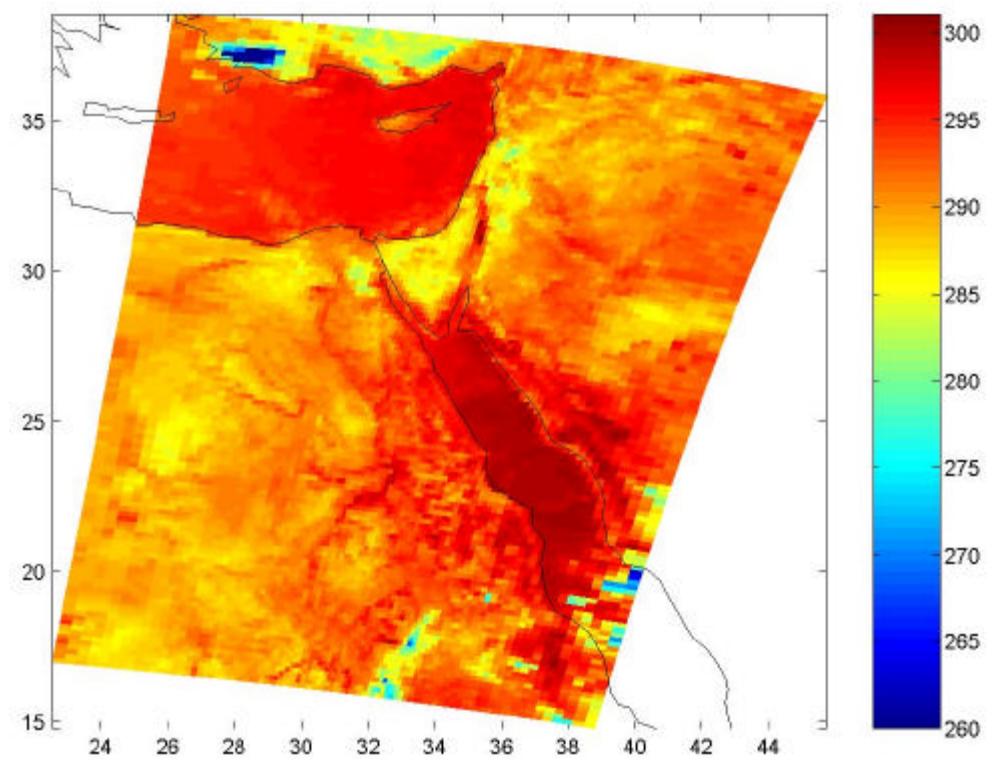
# Single Channel “Surface” Temperatures

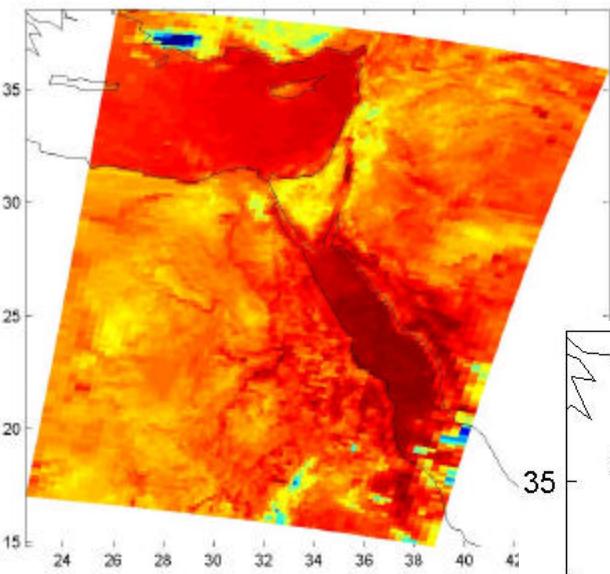
## Granules 236, Night, 14 June 2002

$960.27 \text{ cm}^{-1}$



$2616.38 \text{ cm}^{-1}$





$T_b(960) - T_b(2616)$   
Granules 236, Night, 14 June 2002

